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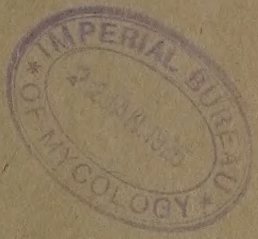


By J. C. ARTHUR.

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# THE GRASS RUSTS OF SOUTH AMERICA; BASED ON THE HOLWAY COLLECTIONS.[1]

By J. C. ARTHUR.

(*Read April 24, 1925.*)

For fifty years the writer was intimately associated with the late Professor E. W. D. Holway in botanical activities. For the first five years, between 1875 and 1880, we directed our attention chiefly to the identification and distribution of the flowering plants of Iowa, of which state we were then both residents. After that period the fungi began to receive attention, especially the smaller forms and particularly the parasitic ones. As we became more familiar with the botanical field, our activities were gradually narrowed and intensified until in 1895 we began the publication of "Descriptions of American Uredineae," and from that time onward the rusts were our chief concern.

Professor Holway was a man of diversified tastes and superior ability. Whatever he undertook he did unusually well. Beginning his career as a banker, in which occupation he laid the foundation of the competence which enabled him in after years to defray the expenses of collection and publication of botanical data, he became noted as an ardent mountain climber and a successful botanical explorer. His contributions to the critical identification and delineation of the rusts also were by no means insignificant.

When sufficiently released from duties as a bank official, he began his botanical explorations, first in the Selkirks and Canadian Rockies, where also his most important mountain ascents were made, then in Mexico and Central America, and finally in South America.

In recent years he found an enthusiastic and intrepid companion for his travels in Mrs. Mary M. Holway, his wife, who has shared the discomforts and the joys of his explorations, and to whom much

[1] Contribution from the Botanical Department of the Purdue University Agricultural Experiment Station.



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credit is due for extent and value of the results. Since the death of Professor Holway on March 31, 1923, Mrs. Holway has supervised the completion of his important publication, the "North American Uredineae," and the assembling and the transfer of his library and specimens to the University of Minnesota.

Having successively brought out of Mexico, Guatemala and Costa Rica by far the greatest number of rusts known for these countries, in each instance much exceeding the efforts of all previous collectors combined, he and his wife decided to give some time to South American exploration. One group of rusts was to receive especial attention, those of the grasses. Such rusts not only include those of the greatest economic importance, but are, with one or two remarkable exceptions, heteroecious, *i.e.*, use very unlike hosts for their life cycle, and therefore invite keenness of observation, and a dependable judgment when dealing with circumstantial evidence, rarely demanded of the collector.

### Itinerary in Western South America.

Somewhat over a year (September 4, 1919 to October 6, 1920) was devoted to the Andean region, including the countries of Chile, Bolivia, Peru and Ecuador, and about the same length of time (August 8, 1921 to August 31, 1922) to the eastern region, including the countries of Brazil, Uruguay, and Argentina, revolutionary turmoil preventing entry into Paraguay. It was the original intention to report the explorations of the western and eastern regions separately. A title was announced for the Andean portion, but completion of the article was interrupted by illness of the writer, and the unavoidable delay gave opportunity to combine the study of the two regions.

Professor and Mrs. Holway disembarked at Valparaiso, Chile, September 4, 1919, the season being early spring, and for nearly six weeks explored the region centering about Santiago. This is not only the oldest part of Chile in point of agricultural occupation, but much the best known part in connection with rusts. As might be expected few virgin or protected areas for vegetation were found. From San Felipe Professor Holway wrote to the author: "Every inch pastured, and mists hang low all day. *Puccinia Malvacearum*

flourishes as never before seen, but nothing else found today." Chile was the original home of *P. Malvacearum*, the mallow rust, from which it has spread to all parts of the world during the last fifty years. A letter from San José de Maipo says: "We are still in semi-desert regions; cacti cover the hills. This fine valley is pastured closely." Again from Talca he wrote: "Since leaving Papudo we have been looking for a place where something grew. Sheep, goats, cattle, etc., eat everything to a half inch. Pichilemu was very barren, but we got one new grass rust."

On October 13 they turned southward and went as far as the region about Puerto Varas, a little north of the great island of Chiloe, and west to east from the seashore up into the mountains above the hot springs of Chillan and the copper mines above Rancagua. From the Termas Minerales de Chillan he wrote on New Year's Day, 1920: "Here we are in the mountains at 2000 meters elevation. Yesterday fourteen collections were made, [list of them given]. You will note that I am chasing grass rusts religiously. I intend that it shall be the greatest collection of grass rusts ever made" [in South America]. Again at the same place four days later he says: "Glorious sunsets, especially when the volcano erupts at the right time. Grass rusts of Chile are mostly with covered sori, often on dead leaves and hard to find, being very small." They returned to Santiago the latter part of January, and on February 13 sailed away from Chile, having secured 313 collections of rusts, of which 121 were on grasses.

Bolivia was next visited, entry being by way of Antofagasta, and the first stop for collecting being at Oruro. They soon proceeded to Cochabamba, situated at 8,300 feet altitude on a plateau almost over the divide. Three weeks were spent here with gratifying success. On March 2, 1920, he wrote: "*Puccinia* on *Bouteloua* with a splendid *Aecidium* on *Opuntia*. They are both rather common [on one hillside, as he explains in his next letter], no other grass rust to be found in the vicinity, and the *Puccinia* well developed near the infected cacti." The aecia of this species had been collected in the same region nearly thirty years before, but the associated telia had not before been seen. A week later he wrote: "Bolivia is very charming. New grass rusts every day. I have

found an *Aecidium* on *Stevia* [afterward determined as the similar but less known *Ophryosporus*] and the grass rust going with it—proof perfect—everywhere that I found the Aecidium there was the *Puccinia* [*P. Poarum*]." Still two days later he reports discovering "a very grand Aecidium on a malvaceous host—clusters of four or five cups, very large. Looking for the grass rust belonging to it, I found great quantities of a remarkable *Puccinia*, with brown sori up to one inch long, and with yellow spores, looking more like a malvaceous rust than a grass rust. It's a grand thing, and absolutely no question about the connection!" Could he have foreseen the unique character and unsuspected relationships which the after-study of this rust (*Puccinia interveniens*) revealed, he would have been even more wildly enthusiastic over its discovery. From taxonomic and evolutionary points of view it is probably the most interesting grass rust known at the present time.

From Cochabamba they proceeded to the capitol city, La Paz, and after three weeks went on to Sorato, a hundred miles or so beyond the railroad terminus. Here were scenes to delight a lover of the mountains. On April 19 he wrote: "This is a glorious place, 2,500 population, they say, seems smaller, 7,800 feet elevation, a few hundred feet above the bottom of the narrow canyon. At the head of the canyon, close by, is the glacier-covered Illampu, said here to be 25,000 feet high [in fact 21,290 feet]. All around the mountains rise to 15,000 feet or more. One of the passes is 18,000 feet. It's all straight up and down. I have been going down, and the climb back at night was tough. So today I climbed, and it's much easier to walk *down* after a day's work. I don't call the collecting first class, still I have added a dozen species of grass rusts not before seen."

A post-card from La Paz, dated May 17, where they had returned a week previous, says: "Off at eight tomorrow, going to Yungas." This proved to be their most important excursion into the wilds, and the only one fully over the divide and down the eastern slopes of the Andes. It was a thirty-one day trip on mule back into a region destitute of accommodations for travellers. From San Felipe, at 10,000 feet altitude, which was reached the first night, came a letter saying: "We sat on the edge of a gasoline hand-car, and in seventy

minutes rode the sixteen miles to the summit of the pass, 15,000 feet." Here they were met by a muleteer with riding mules and a pack mule. He continues: "Yungas means a deep valley, and this is a wonder. At the summit was a great cirque, down which we wound, and then it was down, everlastingly down. We had been told terrible tales of the posadas [lodging houses], but we have a room with two windows, or rather holes, cloth covered, and two beds with clean bedding. The posada is a one-story stone building with grass roof," and all kinds of domestic animals outside the door day and night. "The meals are filling," he says, "even though the sheep was trotting around at 11 A.M., and we ate it at 12 M.!!" Some days later he wrote: "For a week past they fed the pig out of our soup kettle, and as they only rinsed it in dirty water, we were glad that the soup was always boiling hot!!" After the first week they were pleasantly entertained at haciendas, the homes of wealthy land owners. Professor Holway's optimistic spirit, which always refused to see the seamy side of things, was not entirely proof against uncleanly food and high altitude, and some time was taken from collecting by indisposition, which at Coroico, the capitol of the province, amounted to more than a week, but Mrs. Holway came through the experience unaffected. La Paz was again reached on June 18, and a stay of nine days completed the collecting in Bolivia, giving a total of 416 numbers, of which 108 were grass rusts.

On June 27 they took train for Cuzco, Peru, heart of the ancient Inca civilization, situated at 11,000 feet above sea level. The stay in Peru, which included a two-days mule trip to Urubamba, winter home of the Incas, ten days in the desert at Arequipa, a few days at Lima, a day or two at Choisica in the foot hills above Lima, and at Santa Clara, altogether about a month, gave 60 numbers, with 14 of them grass rusts. The small size of the collection is fully accounted for by remembering that it was the dry winter season, and that the region for many centuries was the abode of highly civilized agricultural races, even before the coming of the Spaniards.

Ecuador was next visited, a little more than two months intervening between arrival at Guayaquil on July 30 and departure for New York on October 6. The stops for collecting embraced Huigra, Riobamba at foot of Mt. Chimborazo, and Quito, the Capitol, where

they were accorded much social attention. It was at Quito that the Swedish botanist, G. von Lagerheim, gathered many rusts in 1891, while connected with the University there, and who is still interested in the fungous flora of the region, having two botanists collecting for him at the time of Professor Holway's visit. There was also a long trip by mule-back to Cuenca, where there was good collecting, and even a longer one to the gold mines at Portovelo near Zaruma. From the latter place he writes on September 24: "The mule ride here was glorious—44 hours in the saddle—four days without taking our clothes off, sleeping on the ground and in rock piles. Views were stupendous; trails beyond description, the wet forest very beautiful. Third night we slept high up with views over seven ranges." Thus thirteen months of exploration in the Andes closed with unbounded enthusiasm, an enthusiasm for his science even exceeding that for the beauties of nature, although the latter has been here more abundantly illustrated by citations, because by many persons more readily appreciated. There were secured 216 numbers of rusts in Ecuador, of which 23 were grass rusts. Altogether the South American trip yielded 1,002 rust numbers, 266 of them being rusts on grasses, and 10 being the alternate stages of grass rusts, but on other kinds of plants.

### Interval of Study.

The interval between the two South American trips was devoted to painstaking and intensive study of the accumulated material. Letters from Minneapolis to the writer averaged two and three a week, and were filled with critical notes and data regarding the species then in hand. On April 14, 1921, he wrote: "It is a pleasure to study this big collection, though I must say that the field work among the mountains is equally a joy." Again not long afterward he says: "This warm weather gives me the fever to see palms and sea and snow-covered mountains, and the desire to tramp some hundreds of miles for more rusts!" The early announcement of plans for a second trip southward, therefore, did not come as a surprise. Although anxious to see the results of the first exploration in print, yet the trying climate of Minneapolis and the urge to secure still more ample material for study caused him to begin preparations for departure before the summer was half over.

On July 23, 1921, Professor and Mrs. Holway stepped aboard the SS. "American Legion" at New York, and after a pleasant voyage a letter was dispatched from Rio de Janeiro on August 8, saying: "Arrived here this morning. It is the most glorious place I ever saw."

## Itinerary in Eastern South America.

About 1,045 collections of rusts, 182 being grass rusts, were made during the year and three weeks between arrival and departure from the eastern shores, and all but 34 of these, 19 being grass rusts, were made in Brazil. The itinerary differed somewhat from that of former years in that there were no rough and arduous trips of more than a day's length, most of the collecting being done by short railway or trolley excursions into the regions near large cities.

The city of Rio de Janeiro was made the center of operations from the time of arrival to January 17, 1922, almost daily excursions being taken to places more or less remote, including Nictheroy and its vicinity across the bay, no less than 18 separate names of localities being attached to the collections. During this period of 23 weeks some five or six weeks were spent in the mountain cities of Petropolis, Therezopolis, Friburgo and Nova Friburgo, yielding 137 collections of rusts, of which 18 were on grasses. Another diversion was a thousand mile journey into the state of Minas Garaes, visiting the new capitol of Bello Horizonte, the old capitol of Ouro Prato, the hotel there being over 200 years old but the rooms and food excellent, and also Sabara and Barbacena. A total of 81 collections was made, of which five were grass rusts, and one other was an alternate form on *Solanum*. This trip occupied nearly four weeks, from late in November to the middle of December. Professor Holway wrote under date of December 3, 1921, that Bello Horizonte "is a charming city with a most beautiful country around it. It is early spring, and too early for rusts although there is a wonderful flora now in flower. However, fires have run over all the country, and in my experience that eliminates most of the rusts."

The next collecting center was that of São Paulo, chosen for one reason because "there is a perfect network of railways from here, and many run often so that I can go out in the morning and back at

night," as he wrote on January 20, 1922. São Paulo, a city of about 150,000 inhabitants, lies between 200 and 300 miles southwest of Rio de Janeiro. It was reached by a twelve-hour railway trip.

A month after arrival Professor Holway wrote: "It is still early for rusts, everything very young and fresh. The climate is splendid, and I am feeling wonderfully well. I have covered pretty well all the Santos-Jundiahy Railway, 140 kilometers, walking between stations." A few days later he wrote: "I had a fine day yesterday, getting to the top of the highest peak near here, 1,100 meters only, but with almost all the state of São Paulo visible" from its summit.

The first of the longer trips was northward to the coffee district of Campinas and the mountains of Poços de Caldas near the southernmost edge of the state of Minas Garaes. The region proved to be too well cultivated for good rust collecting, although ten days were occupied, and 47 specimens obtained, 12 being on grasses.

The second notable outing, occupying about a month, was to Campos do Jordão (alt. 6,000 feet), and to the Government Forestry and Meteorological Stations on the slopes of Mt. Itatiaya, reputed to be 2,800 meters and the highest mountain in Brazil. The region is about 50 miles west of São Paulo. On April 24 with Mrs. Holway he walked to the summit of Mt. Itapevá, 1,948 meters altitude. Four days later, still at Campos do Jordão, he wrote: "Blew in at dark from an all-day hike, loaded with rusts, but soaked with rain and covered with red clay. The trip here is a profitable one, if only for the four fine grass rusts, which I am especially interested in."

They arrived on May 5 at the Forestry Station, officially known as Reserva Florestal, and for which a special permit is required, and remained five days. The experiences here were the most interesting and diverting of the whole year's trip. I can not refrain from quoting a few sentences from letters, especially to illustrate the unbounded enthusiasm of Professor Holway, his intense love of the work he was doing, and some of the experiences of a zealous collector of rusts. "May 9, 1922. A glorious hurricane in the mountains yesterday: trees crashing down the mountain sides, and branches flying through the air. Finally they began falling across my trail, and I beat it. So no rusts. Today was still and splendid, and I put a hunk of bread in my pocket, and was out until dark, coming in

with a lot of fine stuff, including one of the finest new grass rusts that I have seen." The next day he "did the twelve miles to the Meteorological Station, 4,200 feet up, in 5½ hours, collecting on the way. Returned in 2 hours and 45 minutes, in a dense fog, the trail deep in mud, and vegetation dripping!!! And the doctors advised putting me in cotton wool, and sticking me into an incubator—or about that!" The collecting went on, however, for a week, and then with Mrs. Holway the ascent of Mt. Itatiaya was accomplished. The summit of the mountain "proved to be an imposing pile of gneiss, with a most remarkable chimney of some 200 meters, in which for an hour we did all sorts of stunts—standing on the guide's shoulders, crawling through S-shaped narrow holes on our sides, etc. The day was perfect and the view extensive and very fine." During the month in the mountains 129 collections were made, 19 being grass rusts.

After leaving the Forest Reserve they returned to São Paulo for a month in order to collect telia for the grass and other rusts, which were only showing uredinia earlier in the season. About a week was then taken to visit Curityba, the capitol of the state of Parana, and the vicinity, some 300 or more miles to the southwest, requiring the use of a coastwise steamer. The results, however, were disappointing, only ten rusts being obtained, of which three were grass rusts.

Returning to São Paulo the latter part of June some twenty-three collections were made during the two weeks following, only two being grass rusts. Although earlier in the month he had written, "both in perfect health," yet now time had to be counted out for illness, which although not alarming at first was the forerunner of the series of bodily complications that resulted in the termination of all activity nine months later. It was now the midwinter season. "The days were warm and lovely," but the nights were cool. On July 7 he wrote from Guaraja on the seacoast near Santos: "São Paulo has a splendid winter climate, if only the hotels had heating: a temperature of 54° in our room night and morning was more than we could stand. I caught the worst cold I ever have had."

On July 25 passage was taken on a Holland steamer from Santos

to Montevideo, capitol of Uruguay. Here only one rust collection was secured, which was on a grass, and in a few days they went to Buenos Aires, capitol of Argentina. The only notable incident of the stay in this large and beautiful city was a visit to that most distinguished mycologist and general botanist of South America, Dr. Carlos Spegazzini of La Plata, and in a few days it was decided to go to a mountain resort, both for ready access to open territory in which to collect, and for the benefit of Professor Holway's health.

On the way to the mountains a day's stop was made at the ancient city of Cordoba, with its three-century old University and its thousand students. Here a few collections were made, aecia on *Stipa* being abundant in the city park.

About a fortnight followed at "La Falda," an attractive health resort in the western part of Argentina, where reasonable modern comforts were obtainable, and "real mountain air." Having been told it was a wild region, he was disappointed to find "there was not an inch of wild land. The hotel is on an estancia where the cattle eat the mountain tops bare as a board." Before leaving he decided, however, that although it was winter and not a grass to be found in flower, yet there were indications of a rich rust flora, particularly as to grass forms, and especially on numerous species of *Stipa* and related genera. There were 28 rust collections made here, including 14 on grasses and one of aecia on an alternate host.

One of the keen regrets attending the eastern South American trip was the necessity of omitting a visit to Paraguay, owing to the repeated revolutions in that country, which rendered travel there difficult and hazardous. As Paraguay could not be visited, and as the west coast could not readily and safely be reached in midwinter, it was decided to return to the United States. On August 31, 1922, the SS. *American Legion* was boarded at Buenos Aires, which landed the travellers in New York on September 25.

## Results of the Eastern Exploration.

Over a thousand collections of rusts, including 182 on grasses, and six on alternate aecial forms, were obtained on this southern visit. Beside these there were brought back many hundreds of collections of flowering plants, partly for the purpose of making

certain the host determinations of the rusts, and partly to supply material for the study of difficult genera. The collections of *Mikania* and *Eupatorium* were subsequently sent to Dr. B. L. Robinson of the Gray Herbarium, and most of the other material to the National Herbarium at Washington, where Dr. F. S. Blake has studied some of the composites, Professor A. S. Hitchcock and Mrs. Agnes Chase all of the grasses, and other specialists have dealt with certain parts of the collections. All who have examined the material supplied by Professor Holway have spoken of the high quality, beauty and completeness of the specimens.

ACKNOWLEDGMENT OF ASSISTANCE.

Many persons became interested in the work undertaken by the Holways, and gave very material assistance. Those in the Andean region to whom Professor Holway desired especially to record his appreciation were in Chile, Col. Alexander W. Chilton, U. S. Military Attaché, and Messrs. Sorrensen, Jones and Grant, of the Braden Copper Co.; in Bolivia, Ernesto Günther in particular, and Geo. W. Schneider, both of Sorato, Moises and Alfredo Ascarrunz, the former the Bolivian Statistician and the latter a Deputado (Representative), and Rafael Taborgo, a Deputado, for letters to the managers of their haciendas, to Manuel Balivian, also to the botanist, H. Buchtien, all of La Paz; in Ecuador, H. Ramel, who gave them the freedom of his home for eight days, and Frederick Tabel, both of Cuzco, Charles Cartwright and Geo. W. Powell of Guayaquil, Leo O. Kellogg of Portovelo, Charles Hartman, the American Minister, L. Söderstrom, the Swedish consul, all of Quito, and Edward Morley of Huigra.

In the eastern region the need of special assistance was not so great. While in Brazil, courtesies were extended by Dr. Eug. Rangel of the Jardim Botanico, Rio de Janeiro; Mr. A. Hempel of the Instituto Agronomico, Campinas; Professor P. H. Rolfs of the Agricultural College, Bello Horizonte; Dr. Hoehne of the Instituto Butantán, São Paulo; and in Argentina by Dr. C. Spegazzini, La Plata.

The generous assistance also rendered the writer by Dr. Spegazzini, who loaned many original collections for study, is most

gratefully acknowledged. Without such aid the comprehensive scope of this article would have been much impaired. In like manner the assistance given by the eminent specialists, Professor A. S. Hitchcock and Mrs. Agnes Chase, in identifying the hosts has been invaluable. They not only determined such specimens as were accompanied by inflorescence, but rendered opinions regarding many fragments of leaves and stems.

## Earlier Collectors of Grass Rusts.

The earliest mycological collectors in the Andean region were Colla, Bertero and Gay, who collected in Chile about 1850, and whose material was largely studied by Montagne and Léveillé. The extent and importance of the results have made their work classical, but only one grass rust was included, a cosmopolitan form on *Phragmites*. During 1890 and 1891 Lagerheim collected in Ecuador, chiefly about Quito, reporting three well known grass rusts, his material being studied in part by Patouillard. In 1895 and 1896 Neger collected in Chile, especially in the vicinity of Concepción, and added some eight species to the Andean list of grass rusts, three being described as new, and also a new variety for one of them, the taxonomic work being in part done by Dietel. In 1909 Spegazzini, the well-known mycologist of Argentina, spent some time collecting in south-central Chile, between Santiago and Valdivia, securing four grass rusts, two of them being additions to the Andean list. In 1912 Mayor, a Swiss mycologist, reported six additional names for the Andean grass rusts, one being described as a new species. These were collected in the higher mountainous region of the central part of Colombia. In 1914 collections were made chiefly in Peru by Dr. and Mrs. Rose, and reported by the writer, which added one grass rust to the Andean list, and one other credited to Peru, but from the Amazonian region. One additional grass rust was recorded from Peru by Hennings as a part of a miscellaneous lot by various collectors.

Summarizing the preceding, it appears that previous to this paper there had been recorded for Chile 16 grass rusts, for Colombia 6, for Ecuador 3, for Peru 2, and for Bolivia none, in all making 27 names. Allowing for duplication of names, and for synonyms, there would be 20 species.

The attempt has not been made to ascertain in detail the collectors who have contributed to the knowledge of grass rusts east of the Andes, or the extent of their contributions. The name that stands prëeminent is that of the distinguished South American botanist, Dr. Carlos Spegazzini of La Plata, who gave particular attention to Argentina, Uruguay and Paraguay. For nearly half a century he has critically observed, described and recorded plants of all classes, and particularly the fungi. One sixth of the names in the present list of 74 species stands to his credit, and as many more names were given to species described by him that have since been identified with earlier names. His publications are numerous, and in any account of the development of knowledge regarding the South American flora will always be of the greatest value. Next to Dr. Spegazzini in the number of collections of fungi, especially the microforms, comes the German explorer, Dr. E. Ule of Berlin, who devoted himself particularly to Brazil, both the northern and southern parts. His material was largely described by Dr. P. Hennings of the Berlin Museum. None other of the many who have collected the smaller fungi has approached the volume of material supplied by Drs. Spegazzini and Ule.

### Value of Seven League Boots.

In the number of collections of South American grass rusts, as well as in the value of the same, those made by Professor Holway much exceed the combined contributions of all previous collectors. In this regard he succeeded in carrying out his ambition to secure "the greatest collection of grass rusts ever made" on the southern continent. He knew how this was to be accomplished, for in one of his letters he wrote: "The only way one gets a collection is to keep his seven league boots on all the time." Of the two thousand collections of rusts which were brought back from the two South American trips, one fourth were grass forms. Of the 74 species of the following list, recognized as certainly occurring in South America, five sixths of them are represented in the Holway collections, and of the 225 species of grasses listed as hosts (belonging to 76 genera) more than one half are so represented.

In fact, the Holway rust collections on grasses add to the South

American flora 27 species, 12 of them being described as new, together with 116 hosts. Most of the species and hosts heretofore credited to South America not in the Holway collections were from areas not visited by the Holways, such as the more northern and more southern parts of the continent.

### Aids to Thorough Work.

The intimate knowledge of flowering plants, which formed a background for Professor Holway's study of the rusts, renders his material more than usually valuable. He collected as good a phanerogamic specimen as possible to represent the host of every rust collection. In the determination of the grass hosts he had the invaluable assistance of the eminent grass specialists, Dr. A. S. Hitchcock and Mrs. Agnes Chase of the United States Bureau of Plant Industry. He also collected many interesting flowering plants, which supplied the basis for many new species by various specialists. When feasible duplicate material of both rusts and flowering plants was taken to be used for exchange and to distribute to special students.

In order to aid in carrying on the field work a microscope, typewriter, photographic outfit and plant press were always part of the supplies. The collections and instruments, together with necessary dryers, made an amount of impedimenta that was troublesome to care for and expensive to transport, all costs being borne from private funds.

The periods following the two excursions to South America were devoted to the assortment of the collections and also to their careful study. A number of the new species were detected by Professor Holway, for which he suggested names and pointed out their salient characters. He also supplied many valuable notes, and provided the photographs used in this article, and many others.

His constant ambition was to make a more complete study of rusts and their hosts in the various regions visited, and he was constantly planning other and more extensive and intensive explorations. He rarely spoke of any physical inhibition, but in a letter of December, 1931, being at the time in perfect health, he wrote: "Likely this is my last long collecting trip. I feel a little aged

sometimes. Hard luck, isn't it, just when one is free to do as he pleases!"

## Survey of South American Grass Rusts.

In studying the very large set of grass rusts brought together by the Holways I have taken into account, so far as possible, all other collections of this sort recorded from South America, and also some additional ones that are in the Arthur Herbarium at Lafayette, Indiana, not previously mentioned in print.

Collectors have been gathering specimens of rusted grasses from various parts of South America between Trinidad and Cape Horn for three quarters of a century, and depositing them in European and American herbaria. A bibliography follows, which is fairly complete, and shows how much of this work has received attention and has been made public by published records.

Much of the material listed in the bibliography I have been able to examine through the kindness of mycological friends. My comments on these records are to be found under the various species treated. They can also be located by means of the index, except such names as precede the systematic part.

## Bibliography of South American Grass Rusts.

(* indicates new species and combinations.)

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*Puccinia purpurea* Cke. on *Sorghum*, *P. levis* (Sacc. & Bizz.) Magn. (p. 67) on *Manisuris*.

Sydow, P. and H., Species in gramineis vigentes, Monographia Uredinearum **4**: 527–613. 1924.

*Uredo andropogonicola* Speg. (p. 529) on *Andropogon*, *U. ignava* Arth. (p. 533) on *Bambusa*, *U. auletica* Speg. on *Bromus*, *U. paulensis* P. Henn. (p. 534) on *Calamagrostis*, *U. cenchrophila* Speg. (p. 535) on *Cenchrus*, *U. Chascolytri* Diet. & Neg. (p. 536) on *Chascolytrus*, *U. eriochloana* Sacc. & Trott. (p. 538) on *Eriochloa*, *U. Henningsii* Sacc. & D. Sacc. (p. 542) on *Panicum*, *U. Panici-Urvilleani* Diet. & Neg. on *Panicum*, *U. uromycoides* Speg. (p. 543) on *Panicum*, *U. poiophila* Speg. (p. 545) on *Poa*, *U. Polypogonis* Speg. (p. 546) on *Polypogon*, *U. Setariae* Speg. (p. 547) on *Setaria*, *U. pencana* Diet. & Neg. (p. 549) on *Stipa*, *U. Bambusarum* P. Henn. (p. 603) on *Arundinaria*, *U. Cameliae* Mayor (p. 604) on *Chaetochloa* (*Setaria*).

Winter, G., Exotische Pilze IV, Hedwigia **26**: 6–18. 1887.

*Puccinia Phragmitis* (Schum.) Körn. (p. 8) on *Phragmites*; *Aecidium graminellum* Speg. (p. 13) on *Bromus*; *Uromyces cuspidatus* Wint. (p. 15) on *Festuca*.

## Collections Not Studied by the Writer.

There are a number of collections recorded under the old names of *Puccinia rubigo-vera*, *P. sessilis*, *P. straminis*, etc., which I have not seen, and which can not be accurately placed without micro-

scopic study. These when examined may add additional hosts and localities.

There is a collection recorded (Bol. Acad. Nac. Ci. Córdoba 25:38. 1921) of *Puccinia simplex* on *Hordeum distichum*, which might be considered an addition to the list of species given below. It was secured by Dr. Spegazzini in the cultivated fields of the estate "Los Perales" near Santiago in the spring of 1917. Still another collection, made by C. Galander in Argentina, may represent an addition to the flora. It is cited in Sydow's Monog. Ured. 1:724 (1903) under *Puccinia versicolor* Diet. & Holw. Neither of these collections has been seen by the writer.

There are still six additional names which may represent species not mentioned in the list below, but of which I have seen no material and am unable to reach a satisfactory opinion regarding their validity.

*Puccinia pseudophacospora* Speg. (An. Mus. Nac. Hist. Nat. Buenos Aires 31:383. 1922) on *Cenchrus tribuloides*, Recoleta, Asunción, Paraguay.

*Uredo dactylocteniicola* Speg. (l. c. 392) on *Triticum durum*, Tucumán, Paraguay.

*Uredo lejoderma* Speg. (l. c. 396) on *Triticum durum*, Tucumán, Paraguay.

*Uredo Syntherismae* Speg. (l. c. 398) on *Panicum sanguinale*, Asunción, Paraguay.

*Uredo uromycoides* Speg. (An. Mus. Nac. Buenos Aires 6:240. 1898) on *Panicum Phyllanthi*, La Plata, Argentina.

*Uromyces chubutensis* Speg. (An. Mus. Nac. Buenos Aires III. 1:60. 1902) on *Poa chubutensis*, Carren-leofu, Argentina.

## Keys and Indices.

A key to the species and an index both to rusts and their hosts have been added to the systematic account of species. It is hoped that these aids will be materially helpful to students, and especially to those persons who undertake further collections of this character. New species and new combinations are printed in broad-face type. The Roman numerals I, II, III, stand for aecial, uredinial and telial stages, while O stands for pycnia. When in lower case (small) letters

they indicate that only a scanty amount of that stage is present. Synonyms are printed in *Italics*, and new names and combinations in broad-face type.

KEY TO SPECIES.

Teliospores two-celled.
Uredinia present *A*.
*A*. Telia long covered by the epidermis *B*.
*B*. Urediniospore-wall pale or colorless, thin, the pores obscure; paraphyses none or hyphoid *C*.
*C*. Urediniospore-wall echinulate.
Telia on *Zea* ..... 1. *Puc. pallescens.*
Telia on *Chaetochloa* ..... 2. *Puc. Cameliae.*
Telia on *Brachypodium* ..... 3. *Puc. subdigitata.*
Telia on *Festuca* ..... 4. *Puc. mellea.*
Telia on *Agropyron* and *Hordeum* ..... 5. *Puc. glumarum.*
*C*. Urediniospore-wall verrucose.
Telia on *Paspalum* ..... 6. *Puc. compressa.*
*B*. Urediniospore-wall colored, echinulate *D*.
*D*. Paraphyses none or hyphoid; urediniospore-wall echinulate *E*.
*E*. Urediniospore-pores equatorial.
Telia on *Cenchrus* ..... 7. *Puc. Cenchri.*
*E*. Urediniospore-pores scattered.
Telia on *Avena, Hordeum, Lolium* and *Torresia* ..... 8. *Puc. coronata.*
Telia on *Agropyron, Briza, Bromus, Calamagrostis, Festuca, Hordeum, Poa, Trisetum* and *Triticum* ..... 9. *Puc. Clematidis.*
Telia on *Bromus, Hordeum* and *Lolium* ..... 10. *Puc. cryptica.*
*D*. Paraphyses clavate or capitate *F*.
*F*. Urediniospore-pores equatorial.
Telia on *Olyra* ..... 11. *Puc. phakopsoroides.*
*F*. Urediniospore-pores scattered.
Telia on *Aira, Calamagrostis* and *Poa* ..... 12. *Puc. Poarum.*
Telia on *Bromus* and *Elymus* ..... 13. *Puc. montanensis.*
*A*. Telia early, or somewhat tardily naked *G*.
*G*. Urediniospore-wall pale or colorless, the pores obscure; paraphyses none or hyphoid *H*.
*H*. Urediniospore-wall echinulate *I*.
*I*. Urediniospore-wall thick, and thicker above.
Telia on *Chloris* ..... 14. *Puc. Chloridis.*

*I.* Urediniospore-wall evenly thin.
Telia on *Olyra* ..... 15. *Puc. deformata.*
Telia on *Arundinaria* and *Olyra* ... 16. *Puc. Bambusarum.*
Telia on *Tricuspis* ..... 17. *Puc. guaranitica.*
Telia on *Ichnanthus* and *Oplismenus* ..... 18. *Puc. inclita.*
Telia on *Pasaplum* ..... 19. *Puc. macra.*
*H.* Urediniospore-wall verrucose, thick.
Telia on *Trachypogon* ..... 20. *Puc. Trachypogonis.*
Telia on *Paspalum* and *Valota* (*Panicum*) ..... 21. *Puc. panicophila.*
*G.* Urediniospore-wall colored *J.*
*J.* Paraphyses none or hyphoid *K.*
*K.* Urediniospore-wall echinulate *L.*
*L.* Urediniospore-pores equatorial.
Telia on *Eriochloa* and *Paspalum* ..... 22. *Puc. substriata.*
Telia on *Panicum, Paspalum, Syntherisma* and *Valota* .... 23. *Puc. tubulosa.*
Telia on *Axanopus, Chaetochloa, Oplismenus, Panicum, Paspalum, Pennisetum* and *Tricholaena* ..... 24. *Puc. levis.*
Telia on *Panicum* ..... 25. *Puc. negrensis.*
Telia on *Agrostis, Bromus, Calamagrostis, Elymus, Hordeum, Lolium, Poa, Polypogon, Trisetum* and *Triticum* ..... 26. *Puc. graminis.*
Telia on *Chloris* ..... 27. *Puc. cacabata.*
Telia on *Phragmites* ..... 28. *Puc. Phragmitis.*
Telia on *Piptochaetium* ..... 29. *Puc. Piptochaetii.*
Telia on *Poa* ..... 30. *Puc. subandina.*
Telia on *Zea* ..... 31. *Puc. Sorghi.*
*L.* Urediniospore-pores scattered.
Telia on *Andropogon* ..... 32. *Puc. variospora.*
Telia on *Aegopogon* ..... 33. *Puc. Aegopogonis.*
Telia on *Polypogon* ..... 34. *Puc. Polypogonis.*
Telia on *Agrostis* ..... 35. *Puc. Moyanoi.*
Telia on *Bouteloua* ..... 36. *Puc. vexans.*
Telia on *Eriochloa* and *Panicum* 37. *Puc. flaccida.*
Telia on *Sporobolus* ..... 38. *Puc. hibisciata.*
Telia on *Trichloris* ..... 39. *Puc. Trichloridis.*
Telia on *Hordeum* ..... 40. *Puc. tornata.*
*K.* Urediniospore-wall verrucose *M.*
*M.* Urediniospore-pores equatorial.
Telia on *Panicum, Paspalum, Pennisetum* and *Valota* .... 41. *Puc. atra.*
Telia on *Aristida* and *Distichlis* . 42. *Puc. subnitens.*
Telia on *Capriola* (*Cynodon*) ... 43. *Puc. Cynodontis.*

*M.* Urediniospore-pores scattered.
Telia on *Bouteloua* ..... 44. *Puc. Opuntiae.*
Telia on *Chaetochloa* (*Setaria*).. 45. *Puc. Setariae.*
Telia on *Leptochloa* ..... 46. *Puc. Leptochloae.*
Telia on *Melica* ..... 47. *Puc. melicina.*
*J.* Paraphyses clavate or capitate *N.*
*N.* Urediniospore-wall verrucose, with the pores scattered.
Telia on *Sorghastrum* (*Andropogon*) 48. *Puc. virgata.*
*N.* Urediniospore-wall echinulate *O.*
*O.* Urediniospore-pores equatorial.
Telia on *Andropogon*, *Cymbopogon*, *Erianthus* and *Imperata* ..... 49. *Puc. Kaernbachii.*
Telia on *Holcus* (*Sorghum*).... 50. *Puc. purpurea.*
Telia on *Pappophorum* and *Pennisetum* ..... 51. *Puc. Gymnotrichis.*
*O.* Urediniospore-pores scattered.
Telia on *Bromus* ..... 52. *Puc. decolorata.*
Telia on *Nasella* and *Stipa*.... 53. *Puc. Nasella.*
Telia on *Nasella* and *Stipa*.... 54. *Puc. digna.*
Uredinia unknown, probably not formed.
Aecia and telia on *Nasella* and *Stipa* ..... 55. *Puc. graminella.*
Aecia on Malvaceae, telia on *Nasella* and *Stipa*. 56. *Puc. interveniens.*
Aecia unknown, telia on *Gymnopogon* ..... 57. *Puc. Gymnopogonis.*

Teliospores one-celled *A.*
*A.* Telia long covered by the epidermis *B.*
*B.* Urediniospore-wall pale or colorless, echinulate, thin, the pores obscure.
On *Paspalum* ..... 58. *Urom. paspalicola.*
*B.* Urediniospore-wall colored, echinulate, the pores discernible, equatorial.
On *Chaetochloa*, *Lasiacis*, *Panicum* and *Syntherisma* ..... 59. *Urom. leptodermus.*
On *Microchloa* ..... 60. *Urom. Microchloae.*
On *Nasella* or *Stipa* ..... 61. *Urom. argentinus.*
*A.* Telia early or somewhat tardily naked *C.*
*C.* Urediniospore-wall colored or colorless, echinulate *D.*
*D.* Urediniospore-pores equatorial.
On *Sporobolus*, spores smaller ..... 62. *Urom. ignobilis.*
On *Sporobolus*, spores larger ..... 63. *Urom. Sporoboli.*
On *Andropogon* ..... 64. *Urom. Andropogonis.*
*D.* Urediniospore-pores scattered.
On *Epicampes* ..... 65. *Urom. Epicampis.*
On *Eragrostis* ..... 66. *Urom. Eragrostidis.*
On *Bromus* ..... 67. *Urom. bromicola.*
On *Nasella* and *Stipa* ..... 68. *Urom. pencanus.*
On *Festuca*, *Melica* and *Muhlenbergia*.... 69. *Urom. fuegianus.*

Teliospores unknown.
Urediniospore-wall colorless, thin (1–1.5 μ).
Urediniospores globoid (on *Poa*) ..... 70. *Uredo poiophila.*
Urediniospores ellipsoid or obovoid (on *Bambos*). 71. *Uredo ignava.*
Urediniospore-wall colored, thick (2–3 μ), echinulate.
Urediniospore-pores equatorial (on *Andropogon*). 72. *Uredo rubida.*
Urediniospore-pores scattered (on *Chaetochloa*).. 73. *Uredo Setariae.*
Urediniospore-wall colored, thick (2–3 μ), verrucose. 74. *Uredo Panici-Urvilleanum.*

1. PUCCINIA PALLESCENS Arth. Bull. Torrey Club **46**: 111. 1919.

*Uredo pallida* Diet. & Holw.; Holway, Bot. Gaz. **24**: 37. 1897.

Collections of this rust were made in two localities on the Island of Trinidad in 1921, on *Zea Mays* L., by Seaver *3103*, *3110* (Mycologia **14**: 18. 1922). No other South American collections are known. Telia have only once been detected. They were found on *Tripsacum latifolium* from Nicaragua, and are very inconspicuous.

2. PUCCINIA CAMELIAE (Mayor) Arth., Mycologia **7**: 227. 1915.

*Uredo Cameliae* Mayor, Mém. Soc. Neuch. Sci. **5**: 578. 1913.

*Dicaeoma Cameliae* Arth. & Fromme, N. Am. Flora **7**: 293. 1920.

*Chaetochloa scandens* (Schrad.) Scribn. & Merr. (*Setaria scandens* Schrad.), São Joán, São Paulo, Brazil, July 2, 1922, II, III, *1989*.

This rust was first found in Colombia on the same host, and it also occurs in the West Indies and in southern Texas.

3. PUCCINIA SUBDIGITATA Arth. & Holw.; Arth. Am. Jour. Bot. **5**: 468. 1919.

*Dicaeoma subdigitatum* Arth. & Fr. N. Am. Flora **7**: 340. 1920.

*Solenodonta subdigitata* Sydow, Ann. Myc. **19**: 174. 1921.

*Brachypodium mexicanum* (R. & S.) Link, Cochabamba, Bolivia, February 28, 1920, II, *346*; same, March 14, 1920, II, *409*; Sorata, Bolivia, April 18, 1920, II, *544*.

This species has heretofore been known only from Guatemala, the type collection being made by Professor Holway.

4. PUCCINIA MELLEA Diet. & Neg., Bot. Jahrb. **24**: 155. 1897.

*Festuca eriolepis* Desv., Maipo Valley near Santiago, Chile, Oct. 2, 1919, III, *80*; Lorrain Alcalde, Chile, Oct. 11, 1919, III, *105*.

*Festuca megalura* Nutt., Viña del Mar, Chile, September 8, 1919, III, *15*; same, September 14, 1919, III, *23*: Lorrain Alcalde, Chile, October 11, 1919, II, *103*; Constitucion, Chile, October 17, 1919, III, *122*; Valdivia, Chile, November 14, 1919, II, III, *177*.

*Festuca Myuros* L., Papudo, Chile, Sept. 17, 1919, III, *31*.

The type collection, which has been examined by the writer, is said to be on *Festuca muralis*. The rust has not been reported outside of Chile.

5. Puccinia glumarum (Schmidt) Erikss. & Henn. Zeits. Pflanzenkr. 4: 197. 1894.

*Dicaeoma glumarum* Arth. & Fr. N. Am. Flora, 7: 338. 1920.

*Agropyron attenuatum* R. & S., Riobamba, Ecuador, August 11, 1920, II, iii, *869*.

*Hordeum chilense* R. & S., Viñā del Mar, Chile, September 6, 1919, II, *9*.

This is the first report of the occurrence of *Puccinia glumarum* in South America, and it is significant that these collections are from the west side of the Andes. In North America it occurs in the mountainous region of the western part, but not eastward of the Rocky Mountains.

**6. Puccinia compressa** Arthur & Holway sp. nov.

*Paspalum elongatum* Griseb., Cochabamba, Bolivia, February 26, 1920, II, *331*; same II, III, *331½* (type); same, March 12, 1920, II, *403*; Sorata, Bolivia, April 14, 1920, II, *516*.

O and I. Pycnia and aecia unknown.

II. Uredinia amphigenous, scattered, oblong or elongate-oblong, 0.3–1 mm. long, early naked, somewhat pulverulent, brownish-yellow, the ruptured epidermis and paraphyses forming a moderately conspicuous border; paraphyses numerous, peripheral, incurved and appearing spatulate, hyphoid, short, about 6 by 35 μ, the wall colorless, thickened on the convex side, smooth; urediniospores ellipsoid or obovate, 15–22 by 20–28 μ; wall colorless or nearly so, thin, 1–1.5 μ, closely and finely verrucose or echinulate-verrucose, the pores obscure.

III. Telia amphigenous, scattered, oblong, 0.2–0.5 mm. long, long covered by the epidermis, blackish-brown, prominent; teliospores compactly adhering laterally, 12–14 by 50–55 μ, rounded or

truncate above and below, strongly constricted at septum; wall chestnut-brown, very thin, 0.5 $\mu$ or less, much thickened and darker above, 3–5 $\mu$, with an additional outer, colorless or pale yellow layer of equal thickness, smooth; pedicel very short or wanting.

This species is closely allied in its morphological characters, to *Puccinia phakopsoroides*, but differs noticeably in most of the details. As in that species there is no stromatal layer around the telial sorus. The hyaline apex to the teliospores is readily seen without staining

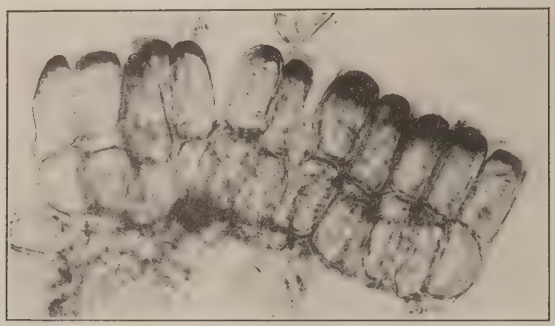

FIG. 1. Teliospores of *Puccinia compressa* on *Paspalum* (collection 331½). Note the transparent outer layer of the upper part of each spore. × 500.

(Fig. 1). The deep color of the telia resides in the spores, and is not due to the host tissue. The teliospores are uniformly two-celled, but each of the two cells is rounded off at the ends as if it were an independent spore.

7. PUCCINIA CENCHRI Dietel & Holway; Holway, Bot. Gaz. **24**: 28. 1897.

*Dicaeoma Cenchri* Arth. Résult. Sci. Congr. Bot. Vienne 344. 1906.

*Uredo cenchrophila* Speg. An. Mus. Nac. Buenos Aires **19**: 316. 1909.

*Cenchrus echinatus* L., Piassaguera near Santos, Brazil, February 9, 1922, II, *1549*.

The type collection of *Uredo cencrophila* has been examined by the writer, through the courtesy of Señor Spegazzini, and found to agree perfectly with other collections of this species.

The species has also been reported on *C. echinatus* from Copacabana, Rio de Janeiro, Brazil, Ule *2549* (Dietel, Hedwigia **38**: 249. 1899), and from Colombia, Mayor *154* (Mém. Soc. Neuch. Sci. Nat. **5**: 472. 1913).

8. PUCCINIA CORONATA Corda, Ic. Fung. **1**: 6. 1837.

*Aecidium Rhamni* Pers. in J. F. Gmel. Syst. Nat. **2**: 1472. 1791.
*Puccinia Lolii* Nielsen, Ugeskr. Landm. **1875**[1]: 549. 1875.
*Puccinia Rhamni* Wettst. Verh. Zool.-Bot. Ges. Wien **35**: 545. 1886.
*Puccinia coronifera* Kleb. Zeits. Pflanzenkr. **4**: 135. 1894.
*Dicaeoma Rhamni* Kuntze, Rev. Gen. **3**[3]: 470. 1898.
*Solenodonta coronata* Sydow, Ann. Myc. **19**: 174. 1921.

*Avena barbata* Brot. (*A. hirsuta* Moench.) Viña del Mar, Chile, September 6, 1919, II, III, *6*, *8½*; same, September 16, 1919, II, *24*; Santiago, Chile, September 29, 1919, II, III, *75*; Temuco, Chile, November 1, 1919, II, *157*; Puerto Varas, Lago Llanquihue, Chile, November 26, 1919, II, *187*; Panimavida, Chile, December 10, 1919, II, III, *213*.

*Avena fatua* L., Sorata, Bolivia, April 13, 1920, II, *513*.

*Avena sativa* L., Temuco, Chile, November 3, 1919, II, III, *158*; Puerto Varas, Chile, November 20, 1919, II, *179*; Linares, Chile, December 23, 1919, II, III, *248*; La Paz, Bolivia, March 23, 1920, II, III, *445*; Friburgo, Rio de Janeiro, Brazil, January 2, 1922, II, III, *1447*.

*Hordeum murinum* L., Viña del Mar, Chile, September 7, 1919, II, iii, *13*.

*Lolium perenne* L., Constitucion, Chile, October 15, 1919, II, iii, *119*; Valdivia, Chile, November 13, 1919, II, *172*; Peulla, Lago Todas los Santos, Chile, November 29, 1919, II, *191*; Parque San Martin, Córdoba, Argentina, August 10, 1922, II, III, *2017½*.

*Lolium temulentum* L., San Felipe, Chile, September 25, 1919, II, *71*.

*Lolium* sp., Lorrain Alcalde, Chile, October 11, 1919, II, iii, *102*.

*Torresia redolans* (Vahl) R. & S., Walls of Spanish Fort, Corral, Chile, November 12, 1919, II, *168*.

The species is also recorded on *Avena sativa* from Quito, Ecuador (Bull. Soc. Myc. France **7**: 169. 1891), and from S. Juan, Argentina

(An. Mus. Nac. Buenos Aires III, 1: 61. 1902); on *Avena hirsuta* from La Plata, Argentina (Speg. An. Mus. Nac. Buenos Aires **6**: 220. 1899; Fungi Chil. 19. 1910); on *Avena fatua* from La Plata, Argentina (An. Mus. Nac. Buenos Aires **6**: 220. 1899); and on *Lolium perenne* from La Plata, Argentina (An. Mus. Nac. Buenos Aires **19**: 297. 1909).

9. PUCCINIA CLEMATIDIS (DC.) Lagerh. Tromsö Mus. Aarsh. **17**: 54. 1895.

*Aecidium Clematidis* DC. Fl. Fr. **2**: 243. 1805.
*Uredo rubigo-vera* DC. in part. Fl. Fr. **6**: 83. 1815.
*Puccinia Elymi* Westend. Bull. Acad. Brux. **18**$^2$: 408. 1851.
*Puccinia rubigo-vera* Wint. in part, in Rab. Krypt. Fl. 1$^1$: 217. 1881.
*Puccinia Agropyri* Ellis & Ev. Jour. Myc. **7**: 131. 1892.
*Puccinia triticina* Erikss. Ann. Sci. Nat. VIII, **9**: 270. 1899.
*Puccinia brachypus* Speg. An. Mus. Nac. Buenos Aires III, 1: 61. 1902.
*Puccinia Triticorum* Speg. An. Mus. Nac. Buenos Aires III, 1: 65. 1902.
*Uredo auletica* Speg. An. Mus. Nac. Buenos Aires III, 1: 65. 1902.
*Dicaeoma Clematidis* Arth. Résult. Sci. Congr. Bot. Vienne 344. 1906.

*Clematis dioica* L., Quito, Ecuador, August 13, 1920, O, I, *879*.

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*Agropyron attenuatum* R. & S., La Paz, Bolivia, March 19, 1920, II, III, *427*.

*Briza Calotheca* (Trin.) Hack., Campos do Jordão, São Paulo, Brazil, alt. 1600 meters, April 28, 1922, II, iii, *1792*.

*Briza Lilloi* Parodi, Quito, Ecuador, August 29, 1920, II, *953*.

*Briza stricta* (Hook.) Steud., Pichilemu, Chile, October 12, 1919, II, *108*; Panamavida, Chile, December 17, 1919, II, *240*; Termas de Chillan, Chile, January 2, 1920, II, *268*; Cochabamba, Bolivia, March 8, 1920, II, III, *383*.

*Bromus Buchtienii* Hack., Cochabamba, Bolivia, March 8, 1920, ii, III, *382*.

*Bromus coloratus* Steud., Constitucion, Chile, October 18, 1919, III, *125*; Temuco, Chile, November 1, 1919, II, *156*; Walls of old

Spanish Fort, Corral, Chile, November 12, 1919, II, III, *171*; Puerto Varas, Lago Llanquiline, Chile, November 21, 1919, II, *181*; Railway between Oruro and Cochabamba, Bolivia, March 16, 1920, II, III, *415*; La Paz, Bolivia, March 20, 1920, II, III, *429*; Quito, Ecuador, August 14, 1920, II, *886*; same, August 18, 1920, II, *915*.

*Bromus commutatus apricorum* Simk., Pichilemu, Chile, October 12, 1919, II, *112*.

*Bromus lithobius* Trin., Panamavida, Chile, December 12, 1919, III, *222*.

*Bromus pitensis* H. B. K., Sorata, Bolivia, April 19, 1920, II, III, *552*.

*Bromus stamineus* Desv., Zapallar, Chile, February 1, 1920, ii, III, *308*.

*Bromus unioloides* H. B. K., San José de Maipo, Chile, October 5, 1919, II, *88*; La Paz, Bolivia, March 27, 1920, II, *471*; Quito, Ecuador, August 15, 1920, II, III, *901*.

*Bromus* sp., Quito, Ecuador, August 15, 1920, III, *904*; Córdoba, Argentina, August 11, 1922, II, III, *2019*; La Falda, Argentina, alt. 1,020 meters, August 14, 1922, II, *2029*; same, August 22, 1922, II, *2041*.

*Calamagrostis heterophylla robustior* Pilger, Sorata, Bolivia, April 29, 1920, II, *583*.

*Festuca lasiorrhachis* Pilger, Sorata, Bolivia, April 14, 1920, ii, III, *519*.

*Festuca octoflora* Walt., Panamavida, Chile, December 9, 1919, III, *212*.

*Hordeum chilense* R. & S., Panamavida, Chile, December 9, 1919, II, III, *208*.

*Hordeum murinum* L., San Felipe, Chile, September 25, 1919, II, III, *70*.

*Poa androgyna* Hack., La Paz, Bolivia, April 5, 1920, II, *496*; same, May 14, 1920, II, III, *606*.

*Poa bonariensis* Kunth, Papudo, Chile, September 20, 1919, II, III, *57*; Constitucion, Chile, October 15, 1919, II, III, *114*; same, October 18, 1919, II, III, *120*; Recinto, Chile, January 10, 1920, II, iii, *286*.

*Poa pallens* Poir., Papudo, Chile, September 17, 1919, II, III, *30*.

*Trisetum spicatum* (L.) Richt., La Paz, Bolivia, March 28, 1920, II, III, *478*.

*Triticum aestivum* L. (T. vulgare Vill.), Puerto Varas, Chile, November 18, 1919, II, *178A*; Panamavida, Chile, December 10, 1919, II, III, *214*.

Although this list of 22 hosts is much the longest known for any South American grass rust, yet in North America there are over 150 species of hosts known for this same rust. In the above list only one collection represents the aecial stage, while in North America over 60 species of hosts are known for this stage. It is possible that the species is not as abundant in the southern hemisphere as northward, and possibly when collected its identity has not been clearly recognized.

Through the courtesy of Señor Spegazzini the writer has been able to examine three South American collections, all from Argentina, which represent apparently three of the above synonyms. Two collections were cited when *Puccinia brachypus* Speg. was first published. The first of these, which may be considered the type, was collected at Rufino in November, 1900, on *Bromus auleticus*, and shows an abundance of covered telia with a few intermixed urediniospores. This packet had a line drawn through the specific name and "*auletica*" substituted in a different ink. I can not find that "Puccinia auletica" has ever been established as a species by Spegazzini, although it has been mentioned a number of times in literature, and would be a synonym in any case. In the same publication where the citation is given, but four pages further over, the name *Uredo auletica* Speg. is established, with the same host from the same locality but taken a month later. This collection I have not seen, but the description agrees perfectly with the uredinial part of the first collection.

The second host mentioned under *P. brachypus* is *Triticum sativum*, collected two years later than the first host and in a different locality. The spores agree exactly with those on the *Bromus*.

*Puccinia Triticorum* Speg. was established on a collection of *Hordeum compressum*, made on January 5, 1905, and shows both uredinia and telia. The teliospores are somewhat longer than in the other two collections, but otherwise the same. It doubtless repre-

sents a different race, as this rust is known to have a number of races with spores of somewhat different sizes, and presumably with aecia on different hosts of *Ranunculaceae*.

The species has been recorded on *Clematis bonariensis* Juss., and *C. Hilarii* Spreng. from Argentina (An. Mus. Nac. Buenos Aires **6**: 231. 1899); on *Clematis sericea* H. B. K. from Quito, Ecuador, on *Agropyrum glaucum* R. & S. from Ambato, Ecuador (Bull. Herb. Boiss. **3**: 63. 1895), on *Triticum durum* Desf. from Córdoba, Argentina (An. Mus. Nac. Buenos Aires, **19**: 297. 1909); on *Bromus Schraderi* Kunth, from Colonia Ceres, Argentina (An. Mus. Nac. Buenos Aires **19**: 297. 1909), under the name *Puccinia bromina;* and on *Triticum hybernum* L. and *T. turgidum* L. from Buenos Aires, Argentina (An. Mus. Nac. Buenos Aires **19**: 297. 1909), under the name *Puccinia triticina* Erikss.

It is highly probable that *Uredo Chascolythri* Diet. & Neg. (Bot. Jahrb. **27**: 15. 1899) may belong here, although the spores are said to be verrucose, the only character given that diverges from the usual description of the present species. The writer has not seen material of it. It was collected at Concepción, Chile, on *Chascolythrum trilobum* E. Desv., a synonym of *Briza triloba* Nees.

10. **Puccinia cryptica** Arthur & Holway sp. nov.

*Bromus Trinii* Desv., Papudo, Chile, September, 17, 1919, II, *29*; same, September 18, 1919, ii, III, *40* (type); same, September 19, 1919, II, III, *48*, *54*; Puente Alto near Santiago, Chile, October 3, 1919, II, III, *84*; Constitucion, Chile, October 8, 1919, II, *96*; same, October 20, 1919, ii, III, *135*.

*Lolium multiflorum* Lam., Puente Alto near Santiago, Chile, October 3, 1919, II, *81*; San José de Maipo, Chile, October 8, 1919, II, *98*; Los Angeles, Chile, October 30, 1919, II, *151½*; Panamavida, Chile, December 12, 1919, II, III, *221*.

*Lolium* sp., Constitucion, Chile, October 20, 1919, II, III, *133*; Termuco, Chile, November 3, 1919, II, *161*; Recinto, Chile, January 10, 1920, II, III, *289*.

O and I. Pycnia and aecia unknown.

II. Uredinia amphigenous, evenly scattered without marked discoloration, oval or oblong, 0.3–0.8 mm. long, somewhat tardily

naked by a longitudinal slit of the epidermis, moderately pulverulent, pale cinnamon-brown or yellowish, the ruptured epidermis conspicuous; urediniospores broadly ellipsoid or globoid, 19–26 by 21–29 μ; wall pale- or brownish-yellow, 1–1.5 μ thick, finely echinulate, the pores scattered, 6–8, indistinct.

III. Telia epiphyllous, scattered, oval or oblong, 0.1–0.8 mm. long, long covered by the epidermis, blackish-brown; teliospores irregularly ellipsoid or obovate, 20–32 by 32–46 μ, sometimes with longer and narrower spores intermixed, truncate or obtuse above, more or less narrowed below, slightly or not constricted at septum; wall chestnut brown, 2–3 μ thick, thicker and darker above, 3–6 μ, smooth; pedicel very short, somewhat colored.

This species differs from the preceding one most strongly in the much broader and thicker-walled teliospores. It has been sent to me from the grass herbarium of the U. S. National Museum, on *Hordeum compressum* Griseb., collected by Ernest Gibson, at Buenos Aires, Argentina, without date.

11. Puccinia phakopsoroides Arth. & Mains, Bull. Torrey Club 46: 412. 1919.

*Dicaeoma phakopsoroides* Arth. & Fromme, N. Am. Flora 7: 295. 1920.

*Olyra latifolia* L., Portovelo, Prov. Oro, Ecuador, Sept. 23, 1920, II, III, *1002*.

This inconspicuous and curious grass rust, with its gelatinized outer layer to the teliospores, has been collected a number of times in Cuba and Porto Rico, but now for the first time in South America.

12. Puccinia Poarum Nielsen, Bot. Tidsskr. III. 2: 34. 1877.

*Lycoperdon epiphyllum* L. Sp. Pl. 1185. 1753.

*Puccinia epiphylla* Wettst. Verh. Zool.-Bot. Ges. Wien 35: 541. 1886.

*Uredo Airae* Lagerh. Jour. de Bot. 2: 432. 1888.

*Puccinia pygmaea* Dietel, Hedwigia 36: 29. 1897.

*Puccinia exigua* Dietel, Hedwigia 36: 299. 1897.

*Dicaeoma epiphyllum* Kuntze, Rev. Gen. 3³: 468. 1898.

*Uredo paulensis* P. Henn. Hedwigia 41: 297. 1902.

*Ophryosporus venosissimus* (Rusby) B. L. Robinson, Cochabamba, Bolivia, March 8, 1920, O, I, *381*; same, March 10, 1920, O, I, *391*.

*Aira danthonioides* Trin. (*Deschampsia danthonioides* Munro), Lorrain Alcalde, Chile, October 11, 1919, II, III, *100*.

*Calamagrostis cajatambensis* Pilger, La Paz, Bolivia, March 30, 1920, II, III, *484*.

*Calamagrostis Fiebrigii* Pilger, Cochabamba, Bolivia, March 8, 1920, II, III, *379*; same, III, *380*.

*Calamagrostis montevidensis* Nees, Therezopolis, Brazil, alt. 1050 meters, October 11, 1921, II, *1207*; São Joás, São Paulo, Brazil, March 19, 1922, III, *1649*; Campos do Jordão, São Paulo, Brazil, alt. 1600 meters, April 28, 1922, II, III, *1791*; Itatiaya, São Paulo, Brazil, alt. 2100 meters, May 18, 1922, II, *1858*; Garulhos, São Paulo, Brazil, II, III, June 1, 1922, *1935*; Jaragua near Taipas, Brazil, June 10, 1922, III, *1953*; Curityba, Parana, Brazil, alt. 900 meters, June 29, 1922, II, *1980*.

*Poa annua* L., Santiago, Chile, September 30, 1919, II, *76*; Viña del Mar, Chile, September 6, 1919, II, *7*; Corral, Chile, November 12, 1919, II, III, *170*; Summit of the pass, Oruro-Cochabamba Railway, Bolivia, March 16, 1920, II, *416*; La Paz, Bolivia, March 19, 1920, II, III, *421*; Quito, Ecuador, August 20, 1920, II, III, *929*; Petropolis, Brazil, alt. 700 meters, November 3, 1921, II, *1269*; Parque Sarmiento, Córdoba, Argentina, August 13, 1922, II, *2017*.

*Poa bonariensis* Kunth, Constitucion, Chile, October 17, 1919, II, *124*; Concepción, Chile, October 27, 1919, II, *143*; same, October 29, 1919, II, *146*; Termas de Chillan, Chile, January 5, 1920, II, *274*.

*Poa pratensis* L., San José de Maipo, Chile, October 6, 1919, II, *92*; Temuco, Chile, November 3, 1919, II, *155*; Puerto Varas, Lago Llanquihue, Chile, November 26, 1919, II, *186*.

*Poa secunda* Presl, San José de Maipo, Chile, October 8, 1919, II, *99*.

*Relchela panicoides* Steud., Temuco, Chile, November 5, 1919, II, *167*; same, Recinto, Chile, January 9, 1920, II, *277*.

A cosmopolitan rust, but forming teliospores sparingly. The aecia heretofore recognized have been on *Tussilago* and *Petasites* only, but there have been many reasons for thinking that other hosts would eventually be found. The observations of Professor Holway are dependable, and so far as morphological characters, isolation

and propinquity, without cultures, can establish genetic connection, there can be no doubt of the correctness of the present assignment, although the new aecial host is a near relative of *Eupatorium*, and the previously known aecial hosts belong to the tribe *Senecioneae*.

The rust is very common in South America on *Poa annua*. A form from Brazil with spores averaging somewhat smaller than usual was named *P. exigua* (*P. pygmaea*) by Dietel, *l. c.*

The rust occurs upon *Aira* in North America and Europe, but has not before been recognized upon *Calamagrostis*. Through the kindness of the curator of the Berlin Museum the writer has been able to examine the original collection of *Uredo paulensis*, which was found by Puttemans in December, 1901, in the Botanic Garden at São Paulo, Brazil. It shows the abundant and characteristic paraphyses, and spores with about 6 scattered pores.

Beside the above the following collections are in the Arthur Herbarium:

*Agrostis magellanica* Lam., Punta Arenas, Magellanes, Chile, II, III, February 22, 1906, R. Thaxter *60*; same, March, 1906, R. Thaxter *61*.

*Poa annua* L., Ambato, Ecuador, II, 1920, A. Pachano; La Plata, Argentina, II, October, 1905, R. Thaxter *79*.

*Poa bonariensis* Kunth, Buenos Aires, Argentina, II, R. Thaxter *89*.

*Poa fuegiana* (Hook) Hack., Punta Arenas, Magellanes, Chile, II, February, 1906, R. Thaxter *39*.

The first named collections add another host genus to the species. It will be noticed that they were obtained in two localities in the same region as the collection on *Poa fuegianus*, that both the *Poa* and *Agrostis* are endemic species, and furthermore that the *Agrostis* in both instances bears abundant telia, while the *Poa* has only uredinia.

13. PUCCINIA MONTANENSIS Ellis, Jour. Myc. 7: 274. 1893.
*Dicaeoma montanensis* Kuntze, Rev. Gen. $3^3$: 469. 1898.
*Aecidium Fendleri* Tracy & Earle in Greene Pl. Baker. 1: 17. 1901.
*Puccinia Fendleri* Jackson, Brooklyn Bot. Gard. Mem. 1: 246. 1918.

*Pleomeris montanensis* Sydow, Ann. Myc. **19**: 171. 1921.

*Berberis* sp., Termas de Chillan, Chile, December 28, 1919, I, *254*.

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*Bromus brachyanthera* Döll., Serrinha, Parana, Brazil, June 19, 1922, II, *1973*.

*Bromus coloratus* Steud., Termas de Chillan, Chile, Jan. 2, 1920, II, *266*.

*Bromus unioloides* H. B. K., Termas de Chillan, Chile, January 3, 1920, II, iii, *271*.

*Bromus valdivianus* Phil., Termas de Chillan, Chile, December 29, 1919, II, iii, *257*.

*Bromus* sp., Constitucion, Chile, October 15, 1910, ii, III, *116*.

*Elymus agropyroides* J. & C. Presl, Termas de Chillan, Chile, January 5, 1920, II, III, *275*.

*Elymus andinus* Trin., Concepción, Chile, October 25, 1919, II, *137*; Termas de Chillan, Chile, January 2, 1920, II, III, *267*; Recinto, Chile, January 9, 1920, II, III, *276*; same, II, iii, 279, *283*.

*Elymus* sp., Termas de Chillan, Chile, December 31, 1919, II, *264*.

This rust is probably more common than the present collections indicate. The aecia on *Berberis* may have been reported a number of times under various names, but the few collections seen by the writer do not belong here.

The species, which adds a new name to the South American list, differs from *Puccinia epiphylla*, not only in having different aecial hosts, but in having less strongly developed paraphyses, and larger urediniospores and teliospores. The general habit of the rust is somewhat like that of *Puccinia glumarum* in its tendency to produce lines of sori on golden-yellow or pale stripes.

14. Puccinia Chloridis Speg. Rev. Arg. Hist. Nat. **1**: 172. 1891.

*Puccinia Chloridis* Dietel, Hedwigia **31**: 290. 1892.

*Dicaeoma Chloridis* Kuntze, Rev. Gen. $3^3$: 468. 1898.

*Puccinia Dietelii* Sacc. & Sydow; Sacc. Syll. Fung. **14**: 358. 1899.

*Chloris distichophylla* Lag., La Florida, Prov. Nor Yungas, Bolivia, May 29, 1920, II, III, *677*; San Roque, São Paulo, Brazil, March 21, 1922, II, III, *1661*.

The type collection of this species from Paraguari, Paraguay, has not been seen by the writer, but a collection has been examined from Passage, Argentina, which agrees perfectly with the rather detailed description. The latter collection is on *Chloris radiata* Sw. (*C. Beyrichiana* Kunth), and was made by Lorentz & Hieronymus, February, 1873. These records also agree with the numerous North American collections taken from Kansas to central Mexico. The rust reported under this name by Spegazzini in An. Mus. Nac. Buenos Aires **19**: 298 (1909), is not this species, but is given below under *P. cacabata*.

15. Puccinia deformata Berk. & Curt.; Berk. Jour. Linn. Soc. **10**: 357. 1869.

*Dicaeoma deformatum* Kuntze, Rev. Gen. $3^3$: 468. 1898.

This distinctive species, occurring on *Olyra latifolia* L., was not taken by the Holways. The only collection known to me from South America was made by Seaver on Gasparee Island, near Trinidad, British West Indies, April, 1921 (Mycologia **14**: 17. 1922).

16. Puccinia Bambusarum (P. Henn.) Arth. Bot. Gaz. **65**: 467. 1918.

*Uredo Bambusarum* P. Henn. Hedwigia **35**: 255. 1896.
*Uredo Olyrae* P. Henn. Hedwigia **43**: 164. 1904.

*Olyra micrantha* H. B. K., Paineiros, Brazil, August 17, 1921, II, *1047*; Rio de Janeiro, Brazil, August 29, 1921, II, III, *1077*; Petropolis, Brazil, alt. 850 meters, October 22, 1921, II, *1243*; Cascadura, Rio de Janeiro, Brazil, January 12, 1922, II, III, *1473*; Guaruja, Santos, Brazil, July 18, 1922, II, *2014*, II, III, *2018*; Reserva Florestal, Itatiaya, Brazil, May 10, 1922, II, *1840*.

The history of this species has been recorded by the writer in the Botanical Gazette for May, 1918 (**65**: 467–468); and the type collections of Hennings' *Uredo Bambusarum* and *U. Olyrae* have been examined. Both collections were made by Ule, the first in Peru, on *Arundinaria* sp. (not *Olyra*, as reported), and the second in Brazil, on *Olyra micrantha* (not *Arundinaria*, as stated in the Botanical Gazette *l. c.*). The first of these two collections was distributed in

Ule, App. Myc. Brasil. *5*. The species has also been taken in Brazil on *Olyra micrantha* by Eug. Rangel, July, 1913, and by F. Noack, October, 1897, the latter being distributed in Sydow, Uredineen *2097*.

17. Puccinia guaranitica Speg. An. Soc. Ci. Argent. **26**: 12. 1888.

This species was not taken by the Holways. It is known to the writer from the type collection only, which has been examined through the courtesy of Señor Spegazzini. It was collected by B. Balansa *3966*, at Guarapi, Paraguay, October, 1883, on *Tricuspis latifolia* Griseb. The species is a distinctive one, but only the one record of its occurrence has been found.

18. Puccinia inclita Arth. Bull. Torrey Club **46**: 115. 1919.

*Dicaeoma inclitum* Arth. & Fromme, N. Am. Flora **7**: 289. 1920.

*Ichnanthus candicans* (Nees) Döll., Reserva Florestal, Rio de Janeiro, Brazil, May 9, 1922, II, *1828*.

*Ichnanthus glaber* (Raddi) Hitchc. & Chase, Bosque da Saude, São Paulo, Brazil, January 31, 1922, II, *1521*.

*Ichnanthus* sp., Tijuca, Rio de Janeiro, Brazil, December 23, 1921, II, *1422*.

*Oplismenus Minarum* Nees, Sorata, Bolivia, April 17, 1920, II, III, *541*.

This species, which occurs in the West Indies, is now reported for the first time from South America. It is a remarkably distinctive species, especially in its urediniospores, which have a bristly echinulation. It will probably be found eventually on other hosts than those recorded above, the only ones so far known for the species.

19. Puccinia macra Arth. & Holw.; Arth. Am. Jour. Bot. **5**: 465. 1918.

*Dicaeoma macrum* Arth. & Fr. N. Am. Flora **7**: 287. 1920.

*Paspalum candidum* (Humb. & Bonpl.) Kunth, Villa Aspiazu, Nor Yungas, Bolivia, June 1, 1920, II, III, *697*.

*Paspalum pallidum* H. B. K., Quito, Ecuador, August 17, 1920, II, *909*; same, August 30, 1920, II, III *954*.

The type collection of the species was from Guatemala, on *Paspalum candidum*. The only South American collection heretofore known to the writer is in the Arthur Herbarium, and was made at Ambata, Ecuador, in 1920, by A. Pachano. It is on *P. pallidum*.

20. Puccinia Trachypogonis Speg. An. Mus. Nac. Buenos Aires 19: 301. 1909.

This species was not taken by the Holways. The only record of it is by Spegazzini (*l. c.*), on *Trachypogon Montufari* (H. B. K.) Nees, from Argentina, two collections being made, the first one (type) being from Catamarca, January, 1903, and the second from La Rioja, July, 1904. Through the courtesy of Señor Spegazzini I have been enabled to examine both collections, which exhibit a distinctive species of rust, the type material showing both uredinia and telia. The urediniospores have thick colorless walls, in which the pores can not be made out.

21. Puccinia panicophila Speg. An. Mus. Nac. Buenos Aires 19: 300. 1909.

This species was not taken by the Holways. The only record is that of the type collection, which was obtained on the mountains near Cacheuta, Argentina, February 26–27, 1908, and another from the same locality in 1909. The type material has been examined by the writer through the courtesy of Señor Spegazzini, and the host inspected by Professor A. S. Hitchcock of the National Museum.

The species is unusually distinctive on account of its thick-walled, colorless urediniospores, with four equatorial pores, and a very coarsely verrucose surface. The host was given on the original packet as "*Panicum penicillatum*," but when published was changed to *Panicum insulare* (*Valota insularis* (L.) Chase). It is considered by Professor Hitchcock to be more probably *Valota saccharata* (Buckl.) Chase, rather than *V. insularis*. A collection made by Lagerheim, at Quito, Ecuador, May, 1880, and distributed by him as a new species, but the name not published, appears to belong here. The host is accompanied by inflorescence, and has recently been determined by Professor Hitchcock as *Paspalum penicillatum* Hook.

22. PUCCINIA SUBSTRIATA Ellis & Barth. Erythea 5: 47. 1897.

*Uredo Panici* P. Henn. Hedwigia 43: 165. 1904.

*Uredo Henningsii* Sacc., Syll. Fung. 17: 456. 1905.

*Dicaeoma substriatum* Arth. Résult. Sci. Congr. Bot. Vienne 344. 1906.

*Uredo Eriochloae* Speg. An. Mus. Nac. Buenos Aires 19: 319. 1909. Not Sydow, 1906.

*Uredo eriochloana* Sacc. & Trott. in Sacc. Syll. Fung. 21: 810. 1912.

*Puccinia dolosa* Arth. & Fromme, Torreya 15: 262. 1915.

*Puccinia Maublancii* Rangel, Arch. Mus. Nac. Rio de Janeiro 18: 159. 1916.

*Uredo cubangoensis* Rangel, Arch. Mus. Nac. Rio de Janeiro 18: 160. 1916.

*Paspalum conjugatum* Berg., Rio de Janeiro, Brazil, December 20, 1921, II, *1418*; Gavea, Rio de Janeiro, Brazil, January 13, 1922, II, *1476*.

*Paspalum distichum* L., Choisica, Peru, July 23, 1920, II, *781*.

*Paspalum Hankeanum* Presl, Santa Clara, Peru, July 23, 1920, II, iii, *786*.

*Paspalum mandiocanum* Trin., Lapa, São Paulo, Brazil, March 24, 1922, II, *1677*; Campinas, São Paulo, Brazil, April 2, 1922, II, *1690*.

*Paspalum multiflorum* Döll., São Paulo, Brazil, January 18, 1922, II, *1478*; Jundiahy, São Paulo, Brazil, alt. 747 meters, March 17, 1922, II, *1642*.

*Paspalum paniculatum* L., Friburgo, Rio de Janeiro, Brazil, January 6, 1022, II, III, *1464*; same, January 7, 1922, II, *1469*; Villa Augusta, Guarulhos Railway, São Paulo, Brazil, February 25, 1922, II, *1597*; Tremembé, São Paulo, Brazil, March 6, 1922, II, III, *1612*; Arthur Anfim, São Paulo, Brazil, March 15, 1922, II, *1630*; São Joás, São Paulo, Brazil, March 19, 1922, II, III, *1650*; São Roque, São Paulo, Brazil, March 21, 1922, II, III, *1664*; Poá, São Paulo, Brazil, alt. 750 meters, April 14, 1922, II, III, *1731*; Campas do Jordão, São Paulo, Brazil, April 26, 1922, II, III, *1773*; same, alt. 1700 meters, April 28, 1922, II, III, *1781*; same, alt. 1600 meters, April 28, 1922, II, *1793*.

*Paspalum plantagineum* Nees, Lapa, São Paulo, Brazil, June 3, 1922, II, III, *1937*.

*Paspalum plicatulum* Michx., Bello Horizonte, Minas Garaes, Brazil, alt. 920 meters, November 21, 1921, II, *1321*; Alto da Serra, São Paulo, Brazil, January 28, 1922, II, iii, *1504*.

*Paspalum Regnelli* Mez., Juquery, São Paulo, Brazil, February 14, 1922, II, iii, *1554*; Tremembé, São Paulo, Brazil, February 28, 1922, II, iii, 1602; same, March 29, 1922, II, III, *1685*; Jundiahy, São Paulo, Brazil, alt. 747 meters, March 17, 1922, II, *1643*; São Joás, São Paulo, Brazil, March 19, 1922, II, iii, *1651*; São Roque, São Paulo, Brazil, March 21, 1922, II, iii, *1662*; Campinas, São Paulo, Brazil, alt. 700 meters, April 3, 1922, II, *1696*.

*Paspalum remotum* Remy, Cochabamba, Bolivia, February 26, 1920, II, *336*.

*Paspalum virgatum* L., Hacienda "Anacuri," Nor Yungas, Bolivia, June 9, 1920, II, *703*; Ypiranga Mus. Bot. Garden, São Paulo, Brazil, March 13, 1922, II, iii, *1628*.

*Paspalum* sp., Raiz de Serra, Rio de Janeiro, Brazil, alt. 200 meters, November 6, 1921, II, III, *1280*; São Caetano, Brazil, February 22, 1922, *1584*; Campinas, São Paulo, Brazil, alt. 700 meters, April 3, 1922, II, *1697*.

The species is undoubtedly a common one in South America, as it is in southern North America. The species does not possess striking characters by which it can be readily distinguished, and until the alternate host bearing the aecia is discovered, and enough positive observations of the associated stages to determine the range of variability, more or less uncertainty must necessarily attend the determination of individual collections, especially those having only uredinia.

Through the kindness of the authors type material has been examined of *Uredo Eriochloae* Speg., on *Eriochloa annulata*, from Iibcuy, Argentina, *Puccinia Maublancii* Rangel, on *Paspalum densum*, from Rio de Janeiro, Brazil, and *Uredo cubangoensis* Rangel, on *Paspalum mandiocanum*, from Cubango-Niteroy, Brazil, and all three collections show the usual features of *Puccinia substriata*. The specimen distributed as Ule, Myc. Bras. *25*, has also been studied. This seems to be part of the type collection for *Uredo Panici* P. Henn., which was collected by E. Ule, September, 1901, at Juruá-Miry on the river Juruá, now probably within the boundary

of Peru. Although the host is recorded as *Panicum* sp., the leaves, which are about 1.5 cm. wide and 25 cm. long, look far more like *Paspalum* than like *Panicum*. The species has also been collected by Seaver in Trinidad, West Indies, on *Eriochloa punctata*.

This species is most likely to be confused with *Puccinia tubulosa* and *P. levis*, all three occurring on the same group of hosts. In *P. substriata* the urediniospores are moderately large (24–32 μ long), the wall generally cinnamon-brown, the pores 3 or 4, equatorial and usually easily seen, even without heating with lactic acid, while the teliospores are obovate-oblong, with wall slightly or not thickened above.

In *P. tubulosa* the uredinia are often accompanied by hyphoid paraphyses, which are usually inconspicuous, but sometimes are noticeably curved and thickened on one side. The urediniospores may be light cinnamon-brown, but usually are much paler or colorless. The pores are 3 or 4 and equatorial, but usually difficult to see, even by treatment with lactic acid. The teliospores are largely oblong, considerably thickened above, and with the two cells of about the same size and length.

In *P. levis* the urediniospores are about like those of *P. substriata*, but usually with 2 equatorial pores, or sometimes 3, especially on species of *Panicum*. The pores can generally be seen without difficulty. The teliospores are ellipsoid to globoid, with thick, dark walls, thickened somewhat more above, and with the septum often oblique. The pedicels are generally long, and often attached to the spore obliquely.

23. PUCCINIA TUBULOSA (Pat. & Gaill.) Arth. Am. Jour. Bot. 5: 464. 1918.

*Aecidium tubulosum* Pat. & Gaill. Bull. Soc. Myc. France 4: 97. 1888.

*Aecidium Uleanum* Paz. Hedwigia 31: 95. 1892.

*Uredo paspalicola* P. Henn. Hedwigia 44: 57. 1905.

*Puccinia Pilgeriana* P. Henn. Bot. Jahrb. 40: 226. 1908.

*Aecidium solaniphilum* Speg. An. Mus. Nac. Buenos Aires 23: 34. 1912.

*Uredo duplicata* Rangel. Arch. Mus. Nac. Rio de Janeiro 18: 160. 1916.

*Dicaeoma tubulosum* Arth. & Fromme, N. Am. Flora 7: 288. 1920.

*Solanum subscandens* Vell., São Paulo, Brazil, January 23, 1922, O, I, *1495*.

*Solanum torvum* Sw., Rebeiráo Pires, São Paulo, Brazil, March 25, 1922, O, I, *1680*.

*Solanum* sp., Barbacena, Minas Geraes, Brazil, December 13, 1921, O, I, *1391*; São Joás, São Paulo, Brazil, April 13, 1922, O, I, *1728*; Villa Prudente, São Paulo, Brazil, May 31, 1922, O, I, *1922*.

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*Panicum maximum* Jacq., Rio de Janeiro, Brazil, alt. 700 feet, August 10, 1921, II, *1012*.

*Panicum millegrana* Poir., Villa Prudente, São Paulo, Brazil, May 31, 1922, II, III, *1924*.

*Panicum sciurotis* Trin., Reserva Florestal, Itataiya, Rio de Janeiro, Brazil, alt. 1300 meters, May 7, 1922, II, III, *1824*.

*Paspalum distichophyllum* H. B. K., Arthur Anfim, São Paulo, Brazil, March 15, 1922, II, *1633*, *1640*; Mandaque, São Paulo, Brazil, March 23, 1922, II, *1672*.

*Paspalum Humboldtianum* Flügge, Hacienda "La Florida," Sur Yungas, Bolivia, May 29, 1920, II, iii, *678*; Hacienda "Anacuri," Nor Yungas, Bolivia, June 4, 1920, II, III, *712*; same, June 5, 1920, II, *719*; Choisica, Peru, July 23, 1920, II, *782*.

*Paspalum malacophyllum* Trin., Jundiahy, São Paulo, Brazil, alt. 747 meters, March 17, 1922, II, *1645*, *1646*; São Joás, São Paulo, Brazil, alt. 700 meters, April 13, 1922, II, *1725*; Instituto Butantan, São Paulo, Brazil, March 24, 1922, II, iii, *1873*.

*Paspalum mandiocanum* Trin., Lapa, São Paulo, Brazil, March 24, 1922, II, *1675*.

*Paspalum paniculatum* L., Hacienda "Anacuri," Nor Yungas, Bolivia, June 5, 1920, II, *726*; Cantareira, São Paulo, Brazil, February 18, 1922, II, III, *1568*; Rebeiráo Pires, São Paulo, Brazil, March 23, 1922, II, III, *1679* (growing with the aecia on *Solanum 1680*); Guaruja, Santos, Brazil, July 13, 1922, II, *2010*.

*Paspalum pilosum* Lam., City Park in Bello Horizonte, Brazil, November 26, 1921, II, *1337*; Guarulhos, São Paulo, Brazil, alt. 700 meters, January 30, 1922, II, *1510*; Taipas, Brazil, June 10, 1922, II, iii, *1948*.

*Paspalum plicatulum* Michx., São Caetano, São Paulo, Brazil, February 22, 1922, II, *1582*; Lapa, São Paulo, Brazil, March 3, 1922, II, *1607*; Jundiahy, São Paulo, Brazil, alt. 747 meters, March 17, 1922, II, *1647*; São Joás, São Paulo, Brazil, March 19, 1922, II, *1659*.

*Paspalum pruinosum* Trin., São Paulo, Brazil, January 20, 1922, II, *1482*; Jundiahy, São Paulo, Brazil, March 17, 1922, II, *1644*.

*Paspalum Usteri* Hack., roadsides, Juquery, São Paulo, Brazil, February 14, 1922, II, *1553*; Jundiahy, São Paulo, Brazil, March 17, 1922, II, *1641*; Lapa, São Paulo, Brazil, March 24, 1922, II, *1676*.

*Paspalum* sp., Cantareira, São Paulo, Brazil, alt. 737 meters, Feb. 18, 1922, II, III, *1569*; São Joás, São Paulo, Brazil, April 13, 1922, III, *1727* (growing with the aecia on *Solanum 1728*).

*Syntherisma digitata* (Sw.) Hitchc. (*Panicum horizontale* Meyer), Campinas, São Paulo, Brazil, April 3, 1922, II, *1692*.

*Valota saccharata* (Buckl.) Chase (*Panicum lachnanthum* Torr.), Cochabamba, Bolivia, February 25, 1920, II, III, *321*; same, March 5, 1920, II, III; *368*.

In two different localities species of rusted *Paspalum* were found growing closely associated with a shrubby *Solanum* bearing an abundance of aecia, giving the appearance of genetic connection. Of *1679* on *Paspalum paniculatum* and *1680* on Solanum Holway wrote from São Paulo, March 30, 1922, that they "were together and no other rusts around." Such records are important in working out the relationships of the grass rusts. Such observations as these were made in Porto Rico by H. E. Thomas, and were followed up in 1917 by careful cultures, the aeciospores from *Solanum torvum* being sown successfully on *Paspalum paniculatum*.

The type material of *Uredo paspalicola* P. Henn. on *Paspalum conjugatum* Berg., from Peru, and of *Puccinia Pilgeriana* P. Henn., on *Paspalum* sp., from Brazil, have been examined by the writer, through the courtesy of the curator of the Berlin Museum. Also the type material of *Uredo duplicata* Rangel, on *Syntherisma sanguinalis* (L.) Dulac (*Panicum sanguinale* L.), II, iii, from Brazil, was kindly sent by the author for study. The portion transmitted was found to possess a few teliospores in addition to the urediniospores, making the identity all the more certain.

The same rust has also been collected by Seaver in Trinidad, on *Syntherisma digitata* (Sw.) Hitchc., II, and on *P. paniculatum* L., II. It is also reported by Mayor (Mém. Soc. Neuch. Sci. Nat. 5: 578. 1913) on *P. conjugatum*, from Colombia.

24. PUCCINIA LEVIS (Sacc. & Bizz.) Magn. Ber. Deuts. Bot. Ges. 9: 190. 1891.

*Puccinia Paspali* Tracy & Earle, Bull. Torrey Club 22: 174. 1895.
*Puccinia goyazensis* P. Henn. Hedwigia 34: 94. 1895.
*Diorchidium goyazense* Sacc. Syll. Fung. 14: 359. 1899.
*Puccinia Huberi* P. Henn. Hedwigia Beibl. 39: 76. 1900.
*Puccinia Puttemansii* P. Henn. Hedwigia 41: 105. 1902.
*Dicaeoma leve* Arth. & Fromme, N. Am. Flora 7: 286. 1920.

*Axanopus chrysoblepharis* (Lag.) Chase, Hacienda "Anacuri," Nor Yungas, Bolivia, June 4, 1920, III, *708*.

*Axanopus scoparius* Flügge, Hacienda "La Florida," Sur Yungus, Bolivia, May 27, 1920, II, *666*; Villa "Aspiazu," Sur Yungus, Bolivia, June 1, 1920, II, *699*.

*Chaetochloa geniculata* (Lam.) Millsp. & Chase (*Setaria purpurascens* H. B. K.), Cochabamba, Bolivia, February 28, 1920, II, *348*.

*Cymbopogon rufus* (Kunth) Rendle, Reserva Florestal, Itatiaya, Brazil, May 14, 1922, II, III, *1852*.

*Oplismenus Minarum* Nees, Coroico, Nor Yungas, Bolivia, June 14, 1920, II, III, *735*, *736*.

*Panicum demissum* Trin., Campos do Jordão, São Paulo, Brazil, alt. 1600 meters, April 20, 1922, ii, III, *1737*.

*Panicum maximum* Jacq., Rio de Janeiro, Brazil, alt. 800 feet, August 13, 1921, II, *1033*.

*Panicum millegrana* Poir., Tremembé, São Paulo, Brazil, February 18, 1922, II, *1571*; same, February 28, 1922, II, III, *1605*; same, March 6, 1922, II, III, *1615*; Jaragua, peak near Taipas, Brazil, alt. 900 meters, February 19, 1922, II, *1575*; Caetano, São Paulo, Brazil, March 8, 1922, II, *1619*; Prata, São Paulo, Brazil, alt. 825 meters, April 9, 1922, II, *1717*; Reserva Florestal, Itatiaya, Brazil, alt. 600 meters, May 14, 1922, II, III, *1850*; Villa Prudente, São Paulo, Brazil, May 31, 1922, III, *1921*; São Joás, São Paulo, Brazil, July 6, 1922, II, III, *2005*.

*Paspalum pilosum* Lam., Poá, São Paulo, Brazil, alt. 800 meters. March 11, 1922, II, III, *1624*; São Joás, São Paulo, Brazil, March 19, 1922, II, iii, *1657*; Santa Anna, suburbs of São Paulo, Brazil. May 28, 1922, II, III, *1899*.

*Paspalum* sp., Huigra, Chimborazo, Ecuador, August 3, 1920, II, *824*; Mandaque, São Paulo, Brazil, March 23, 1922, III, *1669*.

*Pennisetum multilatum* Hack., Sorata, Bolivia, April 17, 1920, III, *537*.

*Tricholaena rosea* Nees, Rio de Janeiro, Brazil, alt. 1100 feet. August 13, 1921, II, iii, *1034*; same, alt. 25 feet, September 11, 1921, II, iii, *1102*; Villa Augusta, Guarulhos Railway, São Paulo, Brazil, February 25, 1922, II, *1596*; São Roque, São Paulo, Brazil, March 21, 1922, II, *1663*.

The type collection of *Puccinia goyazensis* P. Henn., III, on *Panicum* sp., and another collection so labeled, showing uredinia only, on *P. cyanescens* Nees, both collected by E. Ule in Brazil, have been examined, and found to be excellent examples of *Puccinia levis*. The collection by Spegazzini, from Asunción, Paraguay (An. Mus. Nac. Buenos Aires **31**: 380. 1922), on *Panicum latifolium* L., also shows a fine development of telia. The type collections of *Puccinia Puttemansii* P. Henn., on *Panicum* sp., and *P. Huberi* P. Henn., on *P. ovalifolium* Poir., both from Brazil, have been studied through the courtesy of the cryptogamic curator of the Berlin Museum. They both show uredinia and telia. The teliospores are more oblong, with fewer oblique pedicels, but conform fairly with most collections of the species.

The species has also been collected in South America by Stevens, at Caracas, Venezuela, on *Paspalum pilosum* Lam., II, and by Thaxter, at Buenos Aires, Argentina, on *Manisuris fasciculata* (Lam.) Hitchc. (*Rottboellia fasciculata* Lam.), II, and also on the latter host by Spegazzini (An. Mus. Nac. Buenos Aires **19**: 319. 1909, listed as *Uredo Rottboellii*), II, Ibicuy, Entre Rios, Argentina. It is possible that *Uredo Rottboellii* Diet. (Bot. Jahrb. **32**: 52. 1902) belongs here, but no material has been studied by the writer. It has also been reported on *Rytilix granularis* (L.) Skeels (*Manisuris granularis* Sw.), from Serra do Mel, Rio Blanco, Brazil, (Ann. Myc. **14**: 67. 1916); on *Paspalum Fournierianum maximum* Thell., Colombia (Mayor, Mém. Soc. Neuch. Sci. Nat. **5**: 471. 1913).

25. Puccinia negrensis P. Henn. Hedwigia 43: 159. 1904.

*Panicum millegrana* Poir., Villa Augusta, Guarulhos Railway, São Paulo, Brazil, alt. 750 meters, February 25, 1922, II, III, *1594*.

This Brazilian rust is much like *Puccinia levis*, but with smaller spores. The urediniospores have thin walls, echinulate, with 3 or 4 equatorial pores; the teliospores are more or less globoid, with usually oblique or nearly vertical septa, and uniformly thin walls. The type collection by E. Ule, on *Panicum* sp., has been studied. It came from Moura, on the river Negro, northwestern Brazil, January, 1902.

26. Puccinia graminis Pers. Neues Mag. Bot. 1: 119. 1794.

*Aecidium Berberidis* Pers. in J. F. Gmel. Syst. Nat. 2: 1473. 1791.

*Puccinia poculiformis* Wettst. Verh. Zool.-Bot. Ges. Wien 35: 544. 1886.

*Puccinia jubata* Ellis & Barth. Erythea 4: 2. 1896.

*Puccinia megalopotamica* Speg., An. Mus. Nac. Buenos Aires 6: 224. 1898.

*Dicaeoma poculiforme* Kuntze, Rev. Gen. 3³: 466. 1898.

*Agrostis verticillata* Vill., Cuzco, Peru, June 30, 1920, ii, III, *743*.

*Bromus coloratus* Steud., Puente Alto near Santiago, Chile, October 3, 1919, II, iii, *83*.

*Calamagrostis* sp., Temuco, Chile, November 5, 1919, III, *167A*.

*Elymus andinus* Trin., Recinto, Chile, January 9, 1920, II, *282*; same, III, *283A*.

*Hordeum Gussoneanum* Parl., Panamavida, Chile, December 14, 1919, II, III, *227*.

*Hordeum murinum* L., Panamavida, Chile, December 22, 1919, II, III, *246*.

*Hordeum vulgare* L., Sorata, Bolivia, April 25, 1920, II, III, *569*; Riobamba, Ecuador, August 10, 1920, III, *863*.

*Lolium multiflorum* Lam., Puente Alto near Santiago, Chile, October 3, 1919, ii, III, *82*.

*Poa chilensis* Trin., Corral, Chile, November 12, 1919, II, *169*.

*Polypogon elongatus* H. B. K., Quito, Ecuador, August 20, 1920, II, III, *928*; same, September 2, 1920, II, *958*.

*Trisetum spicatum* (L.) Richt., Panamavida, Chile, December 10, 1919, II, III, *216*.

*Triticum aestivum* L. (T. vulgare Vill.), Puerto Varas, Lake Llanguihne, Chile, November 18, 1919, III, *178*.

This is not a long list of hosts for a species that in the northern temperate zone is one most commonly collected, indicating apparently that the species is not so common in South America as it is in North America and Europe. It is also noticeable that no aecia are included in the list, although many species of *Berberis* occur in the regions visited. Apparently no one else has reported the aecia of this species, but other aecia on *Berberis* have a rich development in South America. Spegazzini has pointed out this absence of the aecia of *P. graminis* in his illustrated article on the South American rusts of barberry in the Revista Chilene de Hist. Nat. **25**: 265. 1921.

Through the kindness of Señor Spegazzini I have been able to examine material of *Puccinia megalopotamica* Speg., collected June 2, 1894, near La Plata, Argentina, on *Triticum pubiflorum*. This is the same locality that the type material came from, and presumably the same host. The original publication states that the type was collected in April, 1894, on *Triticum* sp. I can detect no difference between the specimen that I examined and the usual appearance of *P. graminis*.

The species was collected in its uredinial stage on *Agrostis alba* L., at Ambato, Ecuador, by A. Pachano, in 1920. It has also been recorded on "*Agrostis Hackeliana*" (probably a slip of the pen for *Agrostis Hackelii* Fr.), *Avena sativa*, *Bromus pitensis* and *Poa mulalensis*, all from the Botanical Garden at Quito, Ecuador (Bull. Soc. Myc. France **7**: 169. 1891); on *Avena barbata* from Concepción del Uruguay, Argentina (Hedwigia **35**: 228. 1896); on *Triticum sylvaticum* Salisb. (considered a synonym of *Elymus europaeus* L.) from Ensenada, Argentina (An. Mus. Nac. Buenos Aires **6**: 220. 1899); on *Agropyron* sp., *Hordeum halophilum*, and *H. maritimum* from Argentina (An. Mus. Nac. Buenos Aires **19**: 296. 1909); on *Hordeum compressum*, from Colonia Caroya, Córdoba, Argentina (An. Mus. Nac. Buenos Aires **23**: 25. 1912).

**27. Puccinia cacabata** Arthur & Holway sp. nov.

*Chloris ciliata* Sw., Hacienda "Anacuri," Nor Yungas, Bolivia, June 5, 1920, II, III, *721*.

O and I. Pycnia and aecia unknown.

II. Uredinia amphigenous, scattered, oblong or oblong-linear, 0.5–2 mm. long, early naked, pulverulent, cinnamon-brown, the ruptured epidermis conspicuous; urediniospores broadly ellipsoid or obovoid, 19–23 by 26–29 $\mu$; wall dark cinnamon-brown, 1.5–2 $\mu$ thick, evenly echinulate, the pores 3 or rarely 4, equatorial, distinct.

III. Telia amphigenous, scattered, early naked, pulvinate, prominent, oblong or oblong-linear, 0.5–2 mm. long, chocolate-brown, ruptured epidermis conspicuous; teliospores ellipsoid or somewhat obovate, 19–23 by 29–34 $\mu$, rounded or somewhat obtuse above and below, not or slightly constricted at septum; wall dark chestnut-brown, 2.5–3.5 $\mu$ thick, usually no thicker above, smooth; pedicel tinted, firm, once to twice length of spore.

In general appearance the host resembles a *Paspalum*, and the rust bears a morphological resemblance to *Puccinia substriata*, which occurs largely on species of *Paspalum*. Beside the type collection, it was also detected on a phanerogamic specimen of *Chloris polydactyla* (L.) Sw., in the grass herbarium of the United States Department of Agriculture, which was collected at Pirapora, Minas Geraes, Brazil, February 8, 1914, by Dorsett & Poponoe *343b*. Both collections show an ample development of the rust.

Through the kindness of Señor Spegazzini I have been able to examine the collection which he made near Ledesma, Argentina, April, 1905, and determined as *P. Chloridis* (An. Mus. Nac. Buenos Aires **19**: 298. 1909), which proves to be the above species. The host is given as *Chloris virgata*, but examination at the U. S. National Herbarium has shown it to be *C. polydactyla* (L.) Sw.

28. Puccinia Phragmitis (Schum.) Körn. Hedwigia **15**: 179. 1876.

*Aecidium rubellum* Pers. in J. F. Gmel. Syst. Nat. **2**: 1473. 1791.
*Uredo Phragmitis* Schum. Enum. Pl. Saell. **2**: 231. 1803.
*Puccinia arundinacea* Hedw. f.; Poir. in Lam. Encyc. **8**: 250. 1808.
*Dicaeoma rubellum* Arth. & Fromme, N. Am. Flora **7**: 322. 1920.

This species was not taken by the Holways. It has been reported from Chile and Argentina, on *Phragmites Phragmites* (L.) Karst. (*P. communis* Trin., *P. occidentalis* Trin., *Arundo Phragmites* L., *A. occidentalis* Sieber). The first report was a collection by Bertero at Valparaiso, Chile, (Montaigne in Gay, Hist. Chile **8**: 45.

1852). It was taken at Santiago, Chile, by Philippi (Winter, Hedwigia **26**: 8. 1887), and at Concepción, Chile, by Neger (Dietel & Neger, Bot. Jahrb. **27**: 4. 1899). Two collections have been reported from Argentina, one by Lorentz & Niederlein at Nueva Roma on the river Sauce (P. Hennings, Hedwigia **35**: 228. 1896), and one by Spegazzini at Ensenada near La Plata (An. Mus. Nac. Buenos Aires **6**: 221. 1899). The rust has also been sent to me from the grass herbarium at the U. S. National Museum, taken at Santiago, Chile, January 15, 1920, by Brother Claude.

29. PUCCINIA PIPTOCHAETII Diet. & Neg. Bot. Jahrb. **27**: 3. 1899.

*Piptochaetium ovatum* (T. & R.) Desv., Panamavida, Chile, Dec. 13, 1919, II, III, *225*.

*Piptochaetium tuberculatum* Desv., Sorata, Bolivia, April 19, 1920, III, *547*.

The species has been reported twice before, one collection being by Neger on *Piptochaetium* sp., from Concepción, Chile, on which the name was founded, and another by Spegazzini on *P. tuberculatum*, from La Plata, Argentina, December, 1894, and reported as *Puccinia Stipae* (An. Mus. Nac. Buenos Aires **6**: 225. 1899). A collection on *P. tuberculatum* has also been sent me from the grass herbarium of the U. S. National Museum, made by Ernest Gibson, at Buenos Aires, Argentina, not dated.

30. PUCCINIA SUBANDINA Speg. An. Mus. Nac. Buenos Aires III, **1**: 65. 1902.

This species is only known from the type collection, made by Spegazzini, in 1900, at Carren-leofu, Argentina, on *Poa chorizantha* E. Desv., which I have been permitted to study through the kindness of the collector.

The urediniospores are obovoid or ellipsoid, 20-23 by 31-35 $\mu$; wall cinnamon-brown, 2 $\mu$ thick, echinulate, the pores 3, equatorial.

31. PUCCINIA SORGHI Schw. Trans. Am. Phil. Soc. II, **4**: 295. 1832.

*Uredo Zeae* Desm. Ann. Sci. Nat. II. **13**: 182. 1840; not *U. Zeae* Schw. 1822.

*Puccinia Maydis* Bér. Atti Sci. Ital. **6**: 475, hyponym. 1845.

*Puccinia Zeae* Bér. Klotsch Herb. Viv. Suppl. *18*. 1851.
*Dicaeoma Sorghi* Kuntze, Rev. Gen. $3^3$: 470. 1898.

*Zea Mays* L., Cochabamba, Bolivia, February 26, 1920, III, *338*; Huigra, Prov. Chimborazo, Ecuador, August 4, 1920, III, *837*; Friburgo, Rio de Janeiro, Brazil, January 7, 1922, II, *1467*.

Collections of this rust have been made at Guarapi, Paraguay, by Balansa, in 1882 (Spegazzini, An. Soc. Ci. Arg. **17**: 91, 125. 1884), at Boco de la Riachnelo, Argentina, by Spegazzini, in 1880 (An. Soc. Ci. Arg. **10**: 8. 1880), at Tremembé, São Paulo, Brazil, by Puttemans, in 1901 (Hennings, Hedwigia **41**: 296. 1902), at Morro de Chapeo and Campinas, São Paulo, Brazil, by Noack, in 1896–8 (Sydow, Ann. Myc. **5**: 355. 1907), and at Yarumito, alt. 1340 meters, and Angelopolis, alt. 1600 meters, Colombia, by Mayer, in 1910 (Mém. Soc. Neuch. Sci. Nat. **5**: 472. 1913). All these records have been made under the unestablished name, *Puccinia Maydis*. It was also reported under the name *P. Sorghi* from the island of São Francisco, Brazil, taken by Ule in 1885 (Pazschke, Hedwigia **31**: 96. 1892), and from St. Catharina, Brazil, taken by Lorentz, in 1872 (Hennings, Hedwigia **35**: 244. 1896).

### 32. Puccinia variospora Arthur & Holway sp. nov.

*Andropogon hirtiflorus* (Nees) Kunth, Hacienda "Anacuri," Nor Yungas, Bolivia, June 4, 1920, II, *713*; Quito, Ecuador, August 13, 1920, II, *876*.

*Andropogon saccharoides* Sw., Hacienda "Anacuri," Nor Yungas, Bolivia, June 4, 1920, II, III, *709* (type).

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, scattered, elongate-oblong or linear, 0.1–0.3 mm. broad by 0.5–5.5 mm. long, early naked, reddish or light cinnamon-brown, somewhat pulverulent, ruptured epidermis not distinct; urediniospores globoid, 20–27 $\mu$ in diameter; wall cinnamon-brown or colorless, moderately thick, 2–3 $\mu$, evenly and prominently echinulate, the pores 6–8, scattered, usually distinct when walls are colored.

III. Telia hypophyllous, scattered, oblong or linear, 0.5–4 mm. long, early naked, chestnut-brown, at first pulvinate, becoming pulverulent, ruptured epidermis inconspicuous; teliospores broadly ellipsoid or oblong, 23–26 by 30–35 $\mu$, rounded above and below, slightly or not constricted at septum; wall smooth, light chestnut-

brown, 2–4 $\mu$ thick, slightly thicker above, 3–7 $\mu$; pedicel nearly or quite colorless, slender, once length of spore.

It is possible that the collection made by F. W. Neger (Dietel & Neger, Bot. Jahrb. **27**: 3. 1899) near Concepción, Chile, on *Andropogon hirtiflorus*, showing only uredinia, may belong here, but the writer has had no opportunity to examine it. It was tentatively referred to *P. Andropogonis*, where it probably does not belong.

33. Puccinia Aegopogonis Arth. & Holw.; Arth. Am. Jour. Bot. **5**: 467. 1918.

*Dicaeoma Aegopogonis* Arth. & Fr. N. Am. Flora **7**: 285. 1920.

*Aegopogon cenchroides* Humb. & Bonpl., Sorata, Bolivia, April 16, 1920, II, iii, 535; Quito, Ecuador, August 18, 1920, II, III, *914*.

There appears to be no record of this species having been taken in South America before.

34. Puccinia Polypogonis Speg. An. Mus. Nac. Buenos Aires **19**: 300. 1909.

*Uredo Polypogonis* Speg. An. Mus. Nac. Buenos Aires **6**: 240. 1899.

*Polypogon elongatus* H. B. K., Therezopolis, Brazil, September 28, 1921, II, *1155*; Barbacena, Minas Garaes, alt. 1178 meters, December 13, 1921, II, *1392*; Campos do Jordão, Brazil, May 1, 1922, II, *1797*.

This species has been recorded three times by Spegazzini, but not on the above host. It was taken first on *Polypogon monspeliensis* Desf., January, 1881, in Tuyu, Argentina, and reported in An. Soc. Ci. Arg. **12**: 75 (1881), under the name *Uredo rubigo-vera*. It was also collected in several places in Argentina, Patagonia and Uruguay between 1885 and 1896, on both *P. monspeliensis* and *P. interruptus* H. B. K., these collections being made the basis of the new species, *Uredo Polypogonis* (*l. c.*). The third record is for the type of *Puccinia Polypogonis*, which the writer has examined through the kindness of Señor Spegazzini. It was collected on *P. monspeliensis*, at Lake Muster in Patagonia, December, 1902. The urediniospores have pale walls, with 6–8 readily demonstrated pores.

On October 13, 1921, Holway wrote from Therezopolis that "there is a possibility that no. 1180 on Verbena and no. 1155 are

connected. I have found them together in the greatest abundance in several places." This is *Aecidium Verbenae* Speg., whose alternate form has not yet been established. The evidence in the present instance is much too slight to give it more weight than a suggestion.

35. PUCCINIA MOYANOI Speg. An. Mus. Nac. Buenos Aires **19**: 299. 1909.

This species was not taken by the Holways. Only the original collection is known, which was loaned to the writer by Señor Spegazzini. It was collected on Lake San Martin, in southern Argentina, February, 1903, on *Agrostis Moyanoi* Speg., and shows both uredinia and telia. It is similar in its characters to *Puccinia Polypogonis*, but the urediniospores have 8–10 pores, readily demonstrated with lactic acid, are somewhat thicker walled, and there is an abundance of mesospores in the telia.

36. PUCCINIA VEXANS Farl. Proc. Am. Acad. **18**: 32. 1883.

*Puccinia aristidicola* P. Henn. Hedwigia **35**: 243. 1896.
*Dicaeoma vexans* Kuntze, Rev. Gen. $3^3$: 471. 1898.

*Bouteloua curtipendula* (Michx.) Torr., Cochabamba, Bolivia, March 6, 1920, II, x, III, *372½*.

The only other record for this common North American rust, with its remarkable amphispores, is the collection by Galander, which the writer has examined, made at Córdoba, Argentina, in March, 1881, and under the impression that the grass was an *Aristida*, was described as a new species (*l. c.*) by Hennings. Only the usual urediniospores and teliospores and no amphispores are present on the Córdoba specimen, and only a few amphispores on the Holway collection.

37. PUCCINIA FLACCIDA Berk. & Br. Jour. Linn. Soc. **14**: 91. 1873.

*Puccinia abnormis* P. Henn. Hedwigia **35**: 243. 1896.
*Puccinia subdiorchidioides* P. Henn. Hedwigia **35**: 244. 1896.
*Dicaeoma flaccidum* Kuntze, Rev. Gen. $3^3$: 468. 1898.

*Eriochloa Crus-galli* (L.) Beauv. (*Panicum Crus-galli* L.), Cochabamba, Bolivia, February 25, 1920, II, iii, *323*; same, March 14, 1920, II, III, *412*; Santa Clara, Peru, July 23, 1920, II, *785*.

*Panicum millegrana* Poir., Reserva Florestal, Itatiaya, Brazil, May 9, 1922, II, III, *1834*.

The writer has examined the collections on which the two names by Hennings were based. The first was collected on the river Tercero, province of Córdoba, Argentina, by Galander, March, 1882, and the other on the river Lujan, Buenos Aires, Argentina, by Bettfreund, April 1883. It was also collected by Spegazzini in Tucumán, Argentina, April, 1906 (An. Mus. Nac. Buenos Aires 19: 297. 1909). All three of these collections were on *Eriochloa Crus-galli*.

38. PUCCINIA HIBISCIATA (Schw.) Kellerm. Jour. Myc. 9: 110. 1903.

*Caeoma* (Aecidium) hibisciatum Schw. Trans. Am. Phil. Soc. II. 4: 293. 1832.

*Aecidium Malvastri* Ellis & Tracy, Jour. Myc. 7: 43. 1891.

*Puccinia Muhlenbergiae* Arth. & Holway, Bull. Lab. Nat. Hist. Univ. Iowa 5: 317. 1902.

*Puccinia subglobosa* Speg. An. Mus. Nac. Buenos Aires 19: 300. 1909. Not *P. subglobosa* Diet. & Holway, 1901.

*Puccinia Spegazziniella* Sacc. & Trav.; Sacc. Syll. Fung. 20: 627. 1911.

The only known South American collection of this very common rust of North America was taken by Spegazzini on *Sporobolus asperifolius* (Nees & Meyen) Thurber, at Mendoza, Argentina, January, 1908, and described and figured as a new species (*l. c.*). It was kindly loaned by the collector for study. The rust is abundant in North America, not only on more than one genus of grasses, but also on many species of *Malvaceae*, which bear the aecia. The aecia are small and nearly or quite colorless, and are readily distinguished from the large aecia belonging to *Puccinia interveniens*.

39. PUCCINIA TRICHLORIDIS Speg. An. Mus. Nac. Buenos Aires 19: 298. 1909.

This species is only known from the three collections made in Argentina, 1904-6, by Spegazzini. They are all on *Trichloris mendocina* (Phil.) Kurtz, and from near Perico, Salta, about La Rioja and Mendoza. The first of these was kindly loaned by the

collector. In its morphological characters it much resembles *P. Polypogonis* Speg. The urediniospores have many scattered pores, not easily counted.

### 40. Puccinia tornata Arthur & Holway sp. nov.

*Hordeum andinum* Trin., La Paz, Bolivia, March 27, 1920, II, III, *474* (type); same, April 4, 1920, II, III, *495*; same, April 6, 1920, II, *498*; same, May 16, 1920, II, III, *608*, *609*.

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, rarely epiphyllous, scattered without marked discoloration, oval or oblong, 0.2–0.8 mm. long, somewhat tardily naked by a longitudinal slit of the epidermis, moderately

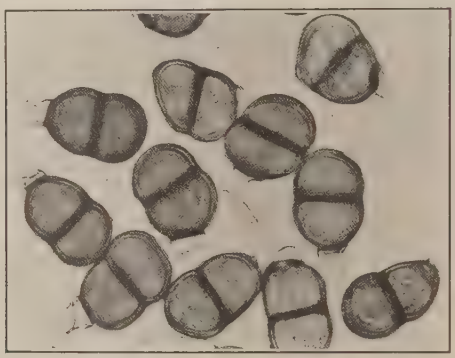

FIG. 2. Teliospores of *Puccinia tornata* on *Hordeum* (collection *474*). × 500.

pulverulent, pale cinnamon-brown or yellowish, the ruptured epidermis conspicuous; urediniospores broadly ellipsoid or globoid, 20–23 by 23–26 μ in the smaller sori, 21–26 by 23–30 μ in the larger sori; wall nearly or quite colorless 1–1.5 μ thick, finely and closely verrucosely-echinulate, the pores scattered, 6–8, usually indistinct.

III. Telia amphigenous, irregularly scattered, ellipsoid or oblong, 0.1–0.5 mm. broad by 0.2–1.3 mm. long, prominent, tardily naked by longitudinal slitting of the epidermis, blackish-brown, pulverulent, ruptured epidermis conspicuous; teliόspores regularly ellipsoid, 16–22 by 26–40 μ, rounded, obtuse, or narrowed above and below, slightly or not constricted at septum; wall chestnut-brown, 1–2 μ thick, usually no thicker above, smooth; pedicel once length of spore, slender, slightly tinted.

The teliospores of this species are well represented by the illustration (fig. 2), taken from type material, no. *474*.

41. PUCCINIA ATRA Diet. & Holw.; Holway, Bot. Gaz. 24:29. 1897.

*Puccinia eslavensis* Dietel & Holway; Holway, Bot. Gaz. 24: 29. 1897.

*Dicaeoma atrum* Arth. Résult. Sci. Congr. Bot. Vienne 344. 1906.

*Pennisetum chilense* (Desv.) Jackson, La Paz, Bolivia, March 20, 1920, II, *438*; same, May 14, 1920, II, *605*.

*Panicum Rudgii* R. & S., Sylvestre, Rio de Janeiro, Brazil, alt. 500 feet, September 16, 1921, II, *1116*.

*Paspalum prostratum* Scrib. & Merr., Sorato, Bolivia, April 12, 1920, II, III, *507*.

FIG. 3. Teliospores of *Puccinia atra* on *Paspalum* (collection *507*). × 500.

*Valota insularis* (L.) Chase (*Panicum leucophaeum* H. B. K.), Taquara, Rio de Janeiro, Brazil, August 30, 1921, II, III, *1082*; Rio de Janeiro, Brazil, alt. 600 feet, September 24, 1921, II, iii, *1152*; Petropolis, alt. 700 feet, November 9, 1921, II, III, *1290*; Prata, Brazil, April 7, 1922, II, *1704*.

This species of rust has not before been reported from South America. It has urediniospores with finely verrucose walls, 2–3.5 μ thick, and 4–6 equatorial pores.

The characteristic teliospores are well shown by the illustration (fig. 3), taken from material of no. *507*.

42. PUCCINIA SUBNITENS Dietel, Erythea **3**: 81. 1895.

*Aecidium Sarcobati* Peck, Bot. Gaz. **6**: 240. 1881.
*Puccinia Aristidae* Tracy, Jour. Myc. **7**: 281. 1893.
*Puccinia thalassica* Speg. An. Mus. Nac. Buenos Aires **6**: 225. 1899.
*Dicaeoma Sarcobati* Arth. Résult. Sci. Congr. Bot. Vienne 344. 1906.
*Puccinia Sarcobati* Bethel; Barth. N. Am. Ured. *2464*. 1921.

*Aristida Adscensionis* L., Arequipo, Peru, July 10, 1920, II, III, *770*, *771*.

*Aristida enodis* Hack., La Paz, Bolivia, March 31, 1920, II, *489*.

*Distichlis spicata* (L.) Greene, Pechilema, Chile, October 11, 1919, II, *106*; Baños de Cauquenes, Rancagua, Chile, January 13, 1920, III, *294*; Cochabamba, Bolivia, March 16, 1920, II, *413*.

All the collections here listed as well as others examined from South America, have somewhat smaller urediniospores and teliospores with thinner walls than most of those from North America, but no other differences are discernible. The sori on *Aristida* do not differ from those on *Distichlis*, and the general habit and texture of the two hosts are the same, although their inflorescence is very unlike.

The species has been recorded from Chile by Neger (Dietel & Neger, Bot. Jahrb. **24**: 155. 1897) from Concepción, and by Spegazzini (Fungi Chilenses *22*. 1910) from Batuco, on *Distichlis thalassica*. It is also known as *P. thalassica* Speg. (*l. c.*), based on a collection from La Plata, Argentina, made in 1893. The original packet, most courteously loaned by Señor Spegazzini, gives the host name as *Distichlis thalassica* in Spegazzini's handwriting, but in the publication it was changed to *D. scoparia*. This original material has been examined at the grass herbarium of the U. S. National Museum and pronounced to be *D. thalassica* and not *D. scoparia*.

Other collections from South America have been found by Mrs. Agnes Chase, to whom I am indebted for many courtesies, among the grass collections at the U. S. National Museum, and are now in the Arthur Herbarium at Lafayette, Indiana:

*D. scoparia* (Kunth) Arech., General Roco, Valley of Rio Negro, Argentina, alt. 250–360 meters, 1914, Fischer *96*; Villa del Rosario, Dept. Rio Secundo, Argentina, 1902, Stuckert *61*.

*D. spicata* (L.) Greene, El Volcán, Prov. Jujuy, Argentina, alt. 2000 meters, Lillo *5265*.

*D. thalassica* (H. B. K.) Desv., Pacasmayo, Peru, 1914, Rose *18518*.

*D. viridis* Phil., Capiapo, Chile, 1888, Philippi.

It is interesting to note that no aecial collections from South America have come to hand that can be assigned to this species, although in North America almost one hundred aecial hosts are known belonging to twenty four families. Holway records that a special search revealed no traces of aecia at the two Chilean localities for his numbers 106 and 294.

43. Puccinia Cynodontis Lacroix, in Desmaz. Pl. Crypt. II. *655*. 1859.

*Aecidium Plantaginis* Ces. Erb. Critt. Ital. *247*. 1859.

*Capriola dactylon* (L.) Kuntze (*Cynodon dactylon* Pers.), Rio de Janeiro, Brazil, roadsides little above sea level, September 11, 1921, II, III, *1103*; Petropolis, Brazil, alt. 700 meters, November 3, 1921, II, iii, *1273*.

This is probably the first record for South America. The rust is common on this grass in many parts of the world. In North America it produces telia sparingly, and chiefly in the southernmost part of its range. The aecia, which occur on species of *Plantago*, have not yet been found in any part of America.

44. **Puccinia Opuntiae** (Magn.) Arthur & Holway, comb. nov.

*Aecidium Opuntiae* Magn. Ber. Deut. Bot. Ges. **16**: 151. 1898.

*Opuntia sulphurea* Don, Cochabamba, Bolivia, March 1, 1920, O, I, *357*.

*Bouteloua simplex* Lag., Cochabamba, Bolivia, March 2, 1920, ii, III, *359*.

O. Pycnia subepidermal, globoid; ostiolar filaments extruded.

I. Aecia caulicolous, subcortical, in large groups, usually about the areolae, cylindric 0.3–0.4 mm. in diameter, 0.5–0.8 mm. high; peridium whitish, firm, the margin erose; peridial cells in face view

polygonal, in side view squarish, abutted with overlapping edge, 30–35 μ broad by 15–23 μ long, the outer wall exceedingly thick, 16–20 μ, transversely striate, smooth, the inner wall 3–4 μ thick, prominently verrucose; aeciospores irregularly oblong, elliptic or globoid, 13–18 by 18–26 μ; wall colorless, 1–1.5 μ thick, closely and finely verrucose.

II. Uredinia not seen; urediniospores globoid or broadly ellipsoid, 16–23 by 19–26 μ; wall light cinnamon-brown or golden, thin, 1–2 μ, closely and finely verrucose, the pores 6–8, scattered, moderately distinct.

III. Telia hypophyllous, oblong or linear, 0.5–4 mm. long, early naked, pulvinate, prominent, blackish-brown, ruptured epidermis not apparent; teliospores broadly ellipsoid, 20–26 by 32–38 μ, rounded at both ends, or somewhat narrowed below, not constricted at septum; wall dark chestnut-brown, 1.5–2.5 μ thick, noticeably thicker above, 3–7 μ; pedicel pale-yellow or colorless, once to twice length of spore; mesospores very numerous, often more than 80 per cent.

The original collection for *Aecidium Opuntiae* was made by O. Kuntze, at Cochabamba, Bolivia, the end of March, 1892, on an undetermined species of *Opuntia*. The collection made by the Holways in the same region agrees well with the elaborate description and illustration by Magnus (*l. c.* pl. 8). The aecia apparently for the most part surround the spines in large spreading groups.

Two other collections are recorded for aecia on *Cactaceae*, which have not been seen by the writer. One on *Opuntia digitalis*, collected by Bruch, February, 1908, in Sierra de Anfama, Argentina, may be the same, according to Spegazzini (An. Mus. Nac. Buenos Aires **19**: 321. 1909), but the description is too meager to venture an opinion. Another on *Cereus* sp., collected by Hieronymus, November 11, 1881, between Pan de Azuacar and Colanchanga, Córdoba, Argentina, given the name *Aecidium Cerei* by Hennings (Hedwigia **35**: 258. 1896) is clearly distinct.

In a letter to the writer dated February 9, 1921, Professor Holway says: "As to the *Aecidium* on *Opuntia*, the *Bouteloa* rust and this *Aecidium* were together on one mountain side, and although both hosts were everywhere there was not a trace of the rust anywhere else." The species is a very striking and distinctive one.

45. Puccinia Setariae Diet. & Holw.; Holway, Bot. Gaz. **24**: 28. 1897.

*Dicaeoma Setariae* Arth. Résult. Sci. Congr. Bot. Vienne 344. 1906.

*Chaetochloa geniculata* (Lam.) Millsp. & Chase, Baños de Cauquenes, Chile, January 13, 1920, II, *290*; La Falda, Córdoba, Argentina, August 14, 1922, II, iii, *2028*.

This name has been used but once for a South American rust. It was assigned by Spegazzini to a collection made by him near Concepción, Chile, on *Setaria caudata* R. & S. (Fungi Chilensis 22. 1910), which the writer has not seen, but the description would indicate that it is not this species. Single collections of rusts on *Chaetochloa* (*Setaria*) are often difficult to place, with the information and observations usually available.

46. Puccinia Leptochloae Arth. & Fromme, Torreya **15**: 263. 1915.

*Dicaeoma Leptochloae* Arth. & Fromme, N. Am. Flora **7**: 321. 1920.
*Puccinia subtilipes* Speg. An. Mus. Nac. Hist. Nat. Buenos Aires **31**: 386. 1922.

This species was obtained by Dr. Spegazzini at Asunción, Paraguay, in July, 1919, on *Leptochloa virgata* (L.) Beauv. No specimen has been seen by the writer. In North America it occurs on *L. filiformis* in southern United States, Mexico and the West Indies.

47. **Puccinia melicina** Arthur & Holway sp. nov.

*Melica scabra* H. B. K., Cochabamba, Bolivia, March 8, 1920, II, III, *384*; La Paz, Bolivia, March 24, 1920, II, III, *457*; same, May 12, 1920, II, III, *598* (type); Cuzco, Peru, June 30, 1920, III, *746*.

O. and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, scattered, oval or oblong, 0.3–0.8 mm. long, early naked, cinnamon-brown, pulverulent, ruptured epidermis evident; urediniospores globose or globoid, 19–26 $\mu$ in diameter; wall cinnamon-brown, moderately thick, 1.5–2.5 $\mu$, closely and finely verrucose, the pores 6–8, scattered, moderately distinct.

III. Telia hypophyllous, scattered, oval or oblong, 0.3–1 mm. long, sometimes longer, early naked, dark chestnut-brown, pulvinate, prominent, ruptured epidermis inconspicuous; teliospores broadly ellipsoid, 21–26 by 29–35 $\mu$, rounded or somewhat obtuse above and below, slightly or not constricted at septum; wall smooth, dark chestnut-brown, 1.5–3 $\mu$ thick, thicker above, 3–7 $\mu$; pedicel colorless, once length of spore, often placed obliquely.

The character of the teliospores is well shown in the illustration (fig. 4), taken from material of no. *746*.

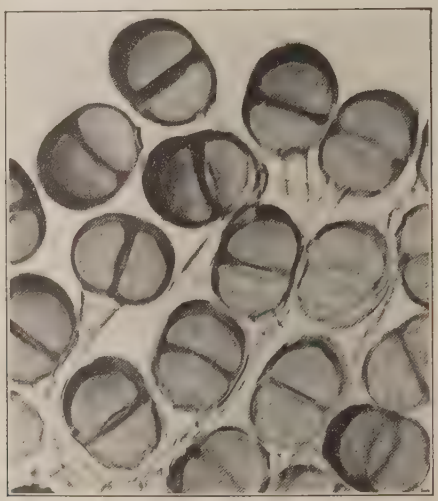

FIG. 4. Teliospores of *Puccinia melicina* on *Melica* (collection *746*). Note the obliquely placed pedicels. × 500.

48. PUCCINIA VIRGATA Ellis & Ev. Proc. Acad. Phila. **1893**: 154. 1893.

*Caeoma Andropogi* Schw. Trans. Am. Phil. Soc. II. **4**: 290. 1832. Not *Puccinia Andropogi* Schw. 1832.

*Dicaeoma virgatum* Kuntze, Rev. Gen. **3**[3]: 471. 1898.

*Sorghastrum nutans* (L.) Nash (*Andropogon nutans* L.), Therezopolis, Brazil, October 11, 1921, II, *1208*; São Paulo, Brazil, January 23, 1922, II, III, *1499*; Tremembé, Brazil, January 24, 1922, II, *1499a*; São Joás, Brazil, March 19, 1922, II, III, *1658*.

The species is here first reported for South America.

49. Puccinia Kaernbachii (P. Henn.) Arth. Bull. Torrey Club 46: 110. 1919.

*Uredo Kaernbachii* P. Henn. Bot. Jahrb. 18: Beibl. 44: 23. 1894.
*Puccinia Nakanishikii* Dietel, Bot. Jahrb. 34: 585. 1904.
*Puccinia andropogonicola* Speg. An. Mus. Nac. Buenos Aires 19: 299. 1909.
*Uredo andropogonicola* Speg. An. Mus. Nac. Buenos Aires 19: 315. 1909.
*Puccinia posadensis* Sacc. & Trott. in Sacc. Syll. Fung. 21: 691. 1912.
*Puccinia venustula* Arth. Mycologia 10: 128. 1918.
*Dicaeoma Kaernbachii* Arth. & Fr., N. Am. Flora 7: 283. 1920.

*Andropogon brevifolius* Sw., Huigra, Ecuador, August 5, 1920, III, *847*.

*Andropogon condensatus* H. B. K., Hacienda "La Florida," Prov. Sur Yungas, Bolivia, May 29, 1920, II, *679*; Therezopolis, Brazil, October 11, 1921, *1208*, *1209*; Barbacena, Minas Garaes, alt. 3400 feet, December 14, 1921, II, *1399*; Nova Friburgo, Rio de Janeiro, January 1, 1922, II, *1439*; São Joás, São Paulo, March 19, 1922, II, III, *1660*.

*Andropogon* sp., Rio de Janeiro, Brazil, alt. 800 feet, December 20, 1921, II, *1417*; Juquery, São Paulo, Brazil, February 14, 1922, II, *1552*; La Falda, Argentina August 24, 1922, II, *2046*.

*Cymbopogon bracteatus* (Willd.) Hitchc. & Chase, Mandaque, São Paulo, Brazil, March 23, 1922, II, *1671*.

*Erianthus angustifolius* Nees, Arthur Anfim, São Paulo, Brazil, March 15, 1922, II, III, *1629*; Taipas, Brazil, June 10, 1922, II, III, *1954*.

*Erianthus asper* Nees, Therezopolis, Brazil, October 8, 1921, II, *1200*.

*Erianthus Trinii* Hack., Tremembé, São Paulo, Brazil, February 28, 1922, II, *1603*.

*Imperata brasiliensis* Trin., Petropolis, Brazil, alt. 700 meters, October 30, 1921, II, *1258*.

*Imperata contracta* (H. B. K.) Hitchc., Therezopolis, Brazil, alt. 1000 meters, October 11, 1921, II, III, *1213*.

This species has dark colored urediniospores with equally dark and conspicuous paraphyses. It occurs in nearly all the warmer regions of the world.

Through the kindness of Señor Spegazzini I have been able to examine two of his collections, on which two of the above synonyms are founded. *Puccinia andropogonicola* was found at Posados, Missiones, Argentina, January, 1901, on *Andropogon condensatus*, and *Uredo andropogonicola* on the same host, near Tucumán, Argentina, April 10, 1906.

50. PUCCINIA PURPUREA Cooke, Grevillea **3**: 15. 1876.

*Dicaeoma purpureum* Kuntze, Rev. Gen. $3^3$: 470. 1898.
*Puccinia Sorghi-halepensis* Speg. An. Mus. Nac. Buenos Aires **31**: 386. 1922.

*Holcus halepensis* L. (*Sorghum halepense* Pers.), Lima, Peru, July 21, 1920, II, iii, *775*; Santa Clara, Peru, July 23, 1920, II, *788*; Prassaguera near Santos, São Paulo, Brazil, Feb. 9, 1922, II, III, *1545*; São Paulo, Brazil, May 24, 1922, II, *1874*.

*Holcus Sorghum* L. (*Sorghum vulgare* Pers.), Rio de Janeiro, Brazil, August 11, 1921, II, III, *1019*.

There are three South American records for this common rust on cultivated sorghums: Seringal Auristella, on the Rio Acre, northeast Peru, 1911, Ule *3516* (Sydow, Ann. Myc. **14**: 67. 1916); Trinidad, British West Indies, Rorer (Arthur, Bot. Gaz. **73**: 66. 1922); and Paraguay (Spegazzini, *l. c.*).

51. PUCCINIA GYMNOTRICHIS P. Henn. Hedwigia **35**: 242. 1896.

*Puccinia Burmeisteri* Speg. An. Mus. Nac. Buenos Aires **6**: 222. 1899.
*Puccinia Arthuri* Sydow, Monog. Ured. **1**: 775. 1904.
*Dicaeoma Arthuri* Arth. & Fromme, N. Am. Flora **7**: 293. 1920.

*Pappophorum vaginatum* Buckl., Cochabamba, Bolivia, March 4, 1920, ii, III, *367*.

*Pennisetum latifolium* Spreng. (*Gymnothrix latifolia* Schult.), Tremembé, São Paulo, Brazil, March 6, 1922, II, III, *1610*; same, May 30, 1922, II, III, *1904*; São Joás, São Paulo, Brazil, alt. 700

meters, April 13, 1922, II, III, *1726*; Pirahy, Parana, Brazil, June 19, 1922, II, III, *1972*.

*Pennisetum Preslii* (Kunth) Trin. (*Gymnothrix Preslii* Kunth), Sorata, Bolivia, April 11, 1920, II, *503*.

*Pennisetum setosum* Sw., Villa Aspiazu, Sur Yungas, Bolivia, May 31, 1920, II, *687*; Hacienda "Anacuri," Nor Yungas, Bolivia, June 4, 1920, II, *714*.

*Pennisetum tristachyum* (H. B. K.) Steud. (*Gymnothrix tristachya* H. B. K.), Quito, Ecuador, August 25, 1920, II, *945*.

*Pennisetum* sp., Campos do Jordão, São Paulo, Brazil, April 30, 1922, II, III, *1795*.

I have been accorded the privilege of studying the type collection of *P. Gymnotrichis*, now in the Berlin Museum, which was taken on *G. latifolia*, in Sierra de Tucumán, Argentina, March, 1872, by Lorentz, and also the type of *P. Burmeisteri*, now in the herbarium of Señor Spegazzini, which was taken on *Pennisetum tristachyum*, at Ensenada near La Plata, Argentina, April 13, 1889. The species was also collected on the last named host by G. von Lagerheim, at Quito, Ecuador, January, 1891.

### 52. **Puccinia decolorata** Arthur & Holway sp. nov.

*Bromus coloratus* Steud., La Paz, Bolivia, March 24, 1920, II, III, *456*.

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, scattered, oval, small, 0.1–0.3 mm. long, early naked, yellowish, pulverulent, ruptured epidermis inconspicuous; paraphyses numerous, strongly capitate, 16–20 by 35–45 μ, colorless, the wall smooth, usually thin, 1–3 μ thick; urediniospores globoid or broadly ellipsoid, 21–23 by 21–26 μ; wall pale yellow, thin, 1 μ, finely and closely echinulate, the pores 6, scattered, moderately distinct.

III. Telia hypophyllous, scattered, intercostal, oval, small, 0.1–0.3 mm. long, early naked, chestnut-brown, somewhat pulverulent, ruptured epidermis inconspicuous; teliospores ellipsoid or obovoid, 19–23 by 29–32 μ, rounded or obtuse above and below, slightly constricted at septum; wall smooth, chestnut-brown, 2–3 μ thick, thicker above, 4–7 μ; pedicel tinted, once length of spore or less.

This species closely resembles *Puccinia melicina* Arth. & Holw. in its general morphological characters, but differs especially in the color and markings of the urediniospores, presence of paraphyses, and absence of oblique teliospores.

53. **Puccinia Nasellae** Arthur & Holway sp. nov.

*Nasella caespitosa* Griseb., Cochabamba, Bolivia, March 11, 1920, II, III, *398*; La Paz, Bolivia, March 24, 1920, II, *461*; same, May 12, 1920, II, III, *600*; Sorato, Bolivia, April 12, 1920, II, III, *508* (type).

*Nasella chilensis* (Trin.) Desv., Viña del Mar, Chile, September 6, 1919, III, *12*; La Paz, Bolivia, March 18, 1920, II, *418*.

*Nasella flaccidula* Hack., La Paz, Bolivia, April 6, 1920, II, III, *497*.

*Nasella pubiflora* (T. & R.) Desv., Cuzco, Peru, June 20, 1920, ii, III, *744*.

*Nasella* sp., La Falda, Córdoba, Argentina August 14, 1922, II, III, *2026a*; same, August 24, 1922, II, iii, *2047*.

*Stipa brachyphylla* Hitchc., La Paz, Bolivia, March 20, 1920, II, iii, *433*.

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, intercostal, ellipsoid or oblong, small, 0.2–0.5 mm. long, early naked, usually pulvinate, somewhat pulverulent, cinnamon-brown, ruptured epidermis inconspicuous; paraphyses usually very numerous, irregularly bent or curved, gradually enlarged above, the wall colored, pale to dark cinnamon-brown, thick, 1–3 $\mu$ below gradually increasing to 3–5 $\mu$ above, smooth; urediniospores globoid or ellipsoid, 20–26 by 20–30 $\mu$; wall cinnamon-brown, about 2 $\mu$ thick, verrucose-echinulate, the pores 6–8, usually distinct, scattered.

III. Telia hypophyllous, rarely amphigenous, ellipsoid or oblong, small, 0.2–0.7 mm. long, early naked, pulvinate, prominent, cinnamon- to blackish-brown, ruptured epidermis inconspicuous; paraphyses often as abundant as with the uredinia; teliospores ellipsoid or ellipsoid-obovate, 16–20 by 30–38 $\mu$, rounded or obtuse above, rounded or somewhat narrowed below, slightly constricted at septum; wall chestnut-brown, about 2 $\mu$ thick, much thicker above, 5–12 $\mu$, smooth; pedicel slender, persistent, once to twice length of spore, colored.

Although the collection made at Sorato, which is taken as the type, was found growing with an abundant development of small, pale aecia on a species of *Desmodium* no. *526* (erroneously labeled *Phaseolus*), the evidence of genetic connection was not strong enough

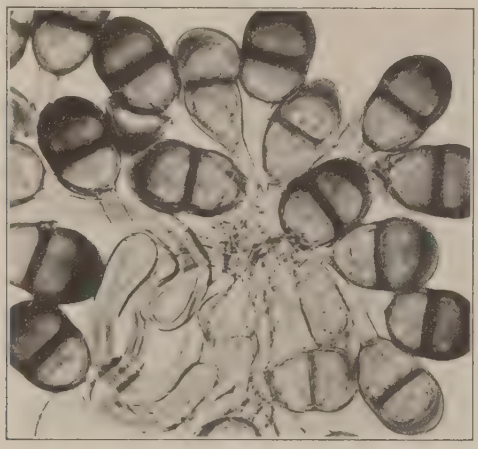

FIG. 5. Teliospores and paraphyses of *Puccinia Nasellae* on *Nasella* (collection *12*). × 500.

to warrant its inclusion. Holway said, however (in letter of September *28*, 1921), that "This is never followed by any other form" on the same host. It is *Aecidium Desmodii* P. Henn. Hedwigia **35**: 259 (1896), which was made a synonym of *Uromyces Hedysari-paniculati* (Schw.) Farl. in the N. Am. Flora **7**: 248 (1912), but doubtless erroneously so.

The abundant development of paraphyses together with the somewhat smaller urediniospores and much smaller teliospores in this species (Fig. 5) distinguishes this species from the one following. Although all collections but one so far identified have been on species of *Nasella* there is every reason to believe that the same rust occurs on various species of *Stipa* also.

54. **Puccinia digna** Arthur & Holway sp. nov.

*Aecidium graminellum Neesianum* Speg. An. Mus. Nac. Buenos Aires **6**: 233. 1899.

*Puccinia graminella Neesiana* Sydow, Monog. Ured. 1: 815. 1904.

*Nasella chilensis* (Trin.) Desv., Papudo, Chile, September 18, 1919, ii, III, *39*.

*Nasella pubiflora* (T. & R.) Desv.; La Paz, Bolivia, March 24, 1920, ii, III, *449*; same, March 28, 1920, II, III, *479*.

*Stipa ibarrensis* H. B. K., Quito, Ecuador, August 16, 1920, II, III, *907*.

*Stipa Ichu* (R. & P.) Kunth, Cochabamba, Bolivia, February 26, 1920, ii, III, *330*; same, February 28, 1920, III, *342*; same, II, III, *345*; same, March 3, 1920, III, *362*; same, March 10, 1920, II, III, *387*, *389*; La Paz, Bolivia, March 24, 1920, II, III, *451* (type); same, May 12, 1920, III, *597*; Sorata, Bolivia, April 16, 1920, II, III, *529*; La Falda, Córdoba, Argentina, August 14, 1922, II, III, *2026*.

*Stipa Neesiana* Trin. & Rupr., Parque Sarmiento, Córdoba, Argentina, August 11, 1922, I, *2020*.

*Stipa* sp., La Falda, Córdoba, Argentina, August 15, 1922, II, *2031*; same, August 20, 1922, I, II, *2039*; same August 22, 1922, II, *2040*, *2042*; same, August 24, 1922, I, 2044; same, I, II, *2045*.

O. Pycnia unknown.

I. Aecia as in Puccinia graminella, but the aeciospores slightly smaller, measuring 18–23 μ in diameter.

II. Uredinia hypophyllous, intercostal, oblong, 0.5–0.8 mm. long, early naked, pulverulent, pale cinnamon-brown, ruptured epidermis evident; paraphyses few, straight, strongly capitate, the wall colorless, uniformly thin, 1–1.5 μ, smooth; urediniospores globoid or broadly ellipsoid, 20–27 by 20–32 μ; wall cinnamon-brown, 1–1.5 μ thick, closely verrucose-echinulate, the pores 4–6, usually evident, scattered.

III. Telia hypophyllous, ellipsoid or oblong, 0.2–0.8 mm. long, early naked, pulvinate, prominent, blackish-brown, ruptured epidermis inconspicuous; teliospores ellipsoid or obovate-oblong, 18–24 by 31–45 μ, rounded or obtuse above, somewhat narrowed below, slightly constricted at septum, wall dark chestnut-brown, 1.5–2.5 μ thick, much thicker above, 6–10 μ, smooth; pedicel slender, persistent, once to twice length of spore, colored.

The aecia of this species on *Stipa Neesiana* from Montevideo, Uruguay, and La Plata, Argentina, were described by Spegazzini in 1899 (*l. c.*), under the name *Aecidium graminella*, var. *Neesiana*, and the uredinia and telia in 1902 under the name *Puccinia graminella* (An. Mus. Nac. Buenos Aires III, 1: 63). For the latter there are two collections cited, both on *Stipa manicata*. The first of these, gathered in the summer of 1896 by J. Arechavaleta, near Montevideo, Uruguay, has been examined by the writer through the courtesy of Señor Spegazzini. The description is also given in Saccardo, Syll. Fung. 14: 349, and is referred to by Sydow, Monog. Ured. 1: 815. 1904.

FIG. 6. Teliospores and one aeciospore of *Puccinia digna* on *Nasella* (collection 179). The dark-walled ellipsoid spores and the paler more oblong ones are well shown. × 500.

The aeciospores are inclined to be slightly smaller than in *P. graminella*, and the teliospores (Fig. 6) are much smaller and so far as seen without any tendency toward a pointed apex. The very abundant and colored paraphyses are especially characteristic of

the species. The collection of aecia on *Stipa hyalina* Nees, made by Spegazzini near La Plata, Argentina (An. Mus. Nac. Buenos Aires 6:233. 1899), may belong here. It has not been seen by the writer.

55. PUCCINIA GRAMINELLA (Speg.) Diet. & Holw.; Dietel, Erythea 3:80. 1895.

*Aecidium graminellum* Speg. Hongos Sud-Am. *29*, hyponym. 1881.
*Aecidium graminellum* Speg. An. Soc. Ci. Arg. **12**:77. 1881.
*Puccinia graminella chilensis* Neger, An. Univ. Santiago **93**: 783. 1896.
*Allodus graminella* Arth. Résult. Sci. Congr. Bot. Vienne 345. 1906.

*Nasella chilensis* (Trin.) Desv., Panamavida, Chile, December 16, 1919, I, III, *237*.

*Stipa setigera* Presl., Panamavida, Chile, Dec. 9, 1919, I, III, *209*; Cochabamba, Bolivia, Feb. 26, 1920, I, *328*; La Paz, Bolivia, March 19, 1920, I, *423*; Sorata, Bolivia, April 12, 1920, I, *511*; Hacienda del Urco, Urabamba Valley, Cuzco, Peru, July 4, 1920, I, *763*.

*Stipa* sp., Zapallar, Chile; February 1, 1920, I, III, *309*.

O. Pycnia unknown.

I. Aecia epiphyllous, scattered, cylindric or somewhat flattened; peridium colorless, erose or even deeply lacerate; peridial cells oblong in face view, rhomboidal in longitudinal section, 12–15 by 30–60 $\mu$, slightly or not overlapping, the outer wall thick, 5–7 $\mu$, transversely striate, the inner wall thin, 1.5–2 $\mu$, noticeably striately verrucose; aeciospores globoid or irregularly ovoid, slightly angular, 16–25 $\mu$ in diameter; wall colorless, thick, 3–4 $\mu$, noticeably and closely striolate-verrucose.

There are in the Holway material eleven collections of aecia on *Stipa*, six of them on *S. setigera* and one on *S. Neesiana*, while one collection is on *Nasella chilensis*. The latter genus is very closely related in habit and general appearance to *Stipa*, and leaves from species of the two genera taken by themselves could rarely be distinguished. It is therefore possible that three of the eleven collections which are imperfectly determined and are marked "*Stipa* sp.," might be either *Stipa* or *Nasella*.

The writer has also examined the type collection of aecia dis-

tributed by Spegazzini in the Hongos Sud-Americanos: Decades Mycologicae Argentinae, which also is reported as on *Stipa* sp., and therefore might be either *Stipa* or *Nasella*. The collections of aecia made at Berkeley, California, in 1894, have also been examined. These were reported as on *Stipa eminens*, but the collections have recently been reexamined and considered to be on two forms of *Stipa*, *S. lepida* and *S. lepida Andersoni*.

These several collections closely resemble one another. In fact, after careful and repeated examination and comparison, it has been impossible to find any characters by which they could be definitely segregated into recognizable groups. There are some differences in the measurements of the spores, but the spores in every collection vary between considerable extremes and the differences in measurements may only indicate variations due to favorable conditions for growth.

Six of the Holway collections on *Stipa* are accompanied by uredinia or telia, and in part on the same leaves with the aecia, which makes it possible to assign two of them respectively to each of the three species, *Puccinia graminella*, *P. digna* and *Uromyces pencanus*. The six collections unaccompanied by other spore forms have been distributed from their association with uredinial or telial collections made at about the same place and time.

The aeciospores are remarkable for their thick colorless walls and the unusual markings. They would pass at first sight as simply verrucose, as indeed they are described in the N. Am. Flora 7: 455. 1921. By most writers, Spegazzini, Dietel and others, the spores are said to be verrucose-striolate, rugulose-striolate, or simply rugulose. The markings are not beads, but short straight ridges, as if each bead were drawn out along the surface to three or four times its breadth. These ridges sometimes anastomose.

The variety *chilensis* was founded upon material encountered but once by its author near Concepción, Chile, on *Stipa manicata*. It differs from the Californian material in having the teliospores, or part of them, prolonged above into an acuminate apex, or "cap." This collection has not been seen by the writer, but a collection found a year or so later by B. Balansa on *Stipa manicata*, at Buenos Aires, Argentina, and cited by Hennings (Hedwigia 35: 243. 1896)

under the name *P. Stipae*, has been studied by the writer through the favor of the curator of the Berlin Museum. This collection is considered by Dietel & Neger (Bot. Jahrb. **24**: 155. 1897) as the same form as the one from Chile.

The more pronounced apical development, of the teliospore, which is sometimes narrower and paler, is to be met with in many collections, and probably has no varietal significance. Three-celled teliospores are mentioned in connection with the original description of the variety *chilensis*, but such variations are not infrequently found in other species of *Puccinia*, and probably possess no systematic importance.

The different species and forms of rusts inhabiting *Stipa* and its near relatives are of unusual interest, probably more so than of any other grass rusts. To classify them understandingly and certainly something more is needed than a morphological study, however abundant the material in hand may be. Many collections from widely separated and unlike localities, taken throughout the different seasons of the year and on many species of hosts are highly desirable. Studies in connection with the microscope and herbarium should be supplemented with careful field observations regarding possible alternate stages and hosts. These should be followed up by controlled cultures. Such cultures can best be undertaken in the region where the rusts abound and the hosts can be grown under favorable conditions, such as are to be found in many localities of South America. Such studies will not only throw light upon the species under consideration, but also have important bearings upon the course of development in all the rusts, and possibly of other fungi. It is a fascinating study that will appeal to any one fitted to undertake it, and wishing a fruitful field for scientific research.

56. PUCCINIA INTERVENIENS (Peck) Bethel; Blasdale, Univ. Calif. Publ. Bot. **7**: 119. 1919.

*Aecidium Modiolae* Thüm. Flora **63**: 31. 1880.
*Roestelia interveniens* Peck, Bull. Torrey Club **10**: 74. 1883.
*Aecidium roestelioides* Ellis & Ev. Jour. Myc. **1**: 93. 1885.
*Aecidium Modiolae Sphaeralceae* P. Henn. Hedwigia **34**: 322, hyponym. 1895.

*Aecidium Malvastri* P. Henn. Hedwigia **36**: 216. 1897.

*Aecidium Sphaeralceae* Speg. An. Mus. Nac. Buenos Aires **19**: 322. 1919; not *A. Sphaeralceae* Ellis & Ev. 1895.

*Dicaeoma interveniens* Arth. & Fromme, N. Am. Flora **7**: 299. 1920.

*Malvastrum capitatum* (Cav.) Griseb., Cochabamba, Bolivia, March 11, 1920, O, I, *397*.

*Malvastrum* sp., La Falda, Córdoba, Argentina, alt. 950 meters, August 21, 1922, I, *2037*.

*Sphaeralcea obtusifolia* Don, Zapallos, Chile, September 22, 1919, O, I, *61*.

*Sphaeralcea* sp., Viña del Mar, Chile, September 10, 1919, I, *17*.

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*Nasella chilensis* (Trin.) Desv., Viña del Mar, Chile, September 10, 1919, III, *18*.

*Stipa Ichu* (R. & P.) Kunth, Cochabamba, Bolivia, March 11, 1920, III, *399*.

*Stipa* sp., La Falda, Córdoba, Argentina, August 20, 1922, III, *2038*.

O. Pycnia amphigenous, in small groups, punctiform, in section 160 μ broad by 180 μ high.

I. Aecia hypophyllous and caulicolous, in circular groups 3–6 mm. in diameter, surrounding the pycnia, large, 0.5–1 mm. high, bag-shaped, opening by a small pore, from which rifts gradually extend to the base forming long and somewhat rigid fibrillae; peridium colorless, the segments entangled but not distinctly recurved; peridial cells oblong, abutted, the outer wall very thick, 10–22 μ, smooth, the inner wall thin, 2–3 μ, noticeably striolately verrucose; aeciospores globoid, 16–27 μ in diameter; wall colorless, thick, 5–7 μ, finely but noticeably striolate-verrucose, the striae three or four times the width.

III. Telia epiphyllous, prominent, pulvinate, very large, linear-oblong, linear-fusiform, or linear, 3–10 mm. long by 1–2 mm. wide, blackish- or chocolate-brown, the ruptured epidermis inconspicuous or in long shreds; teliospores variable in shape and color, ellipsoid, rounded at both ends, dark in color, 27–30 by 35–45 μ, varying to linear-oblong or fusiform, obtuse or acuminate at both ends, pale in color, 20–24 by 48–67 μ, germinating readily, all forms not constricted at septum; wall dark chestnut-brown to pale golden-brown, often darker above, 2–3 μ thick, 4–18 μ above, smooth; pedicel colorless, once to thrice length of spore.

The proof that this rust was truly heteroecious was first demonstrated by E. Bethel by observations and cultures made in Colorado. Before that time it was confused with another heteroecious rust, *Puccinia Burnettii* (as in the N. Am. Flora 7: 299), whose aecia are on *Eurotia*.

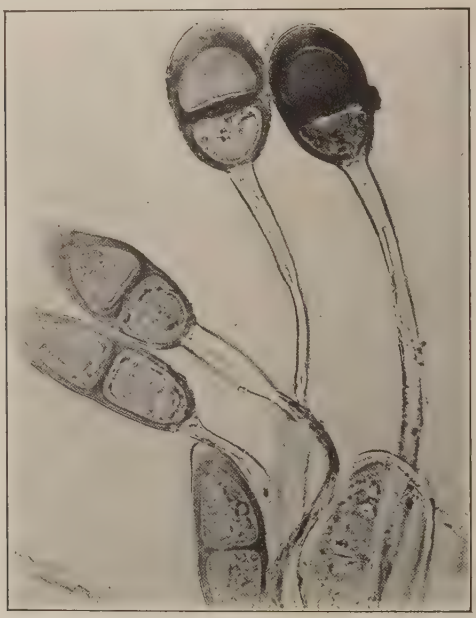

FIG. 7. Teliospores of *Puccinia interveniens* on *Nasella* (collection *18*). The extremes in form and depth in color are fairly well shown. × 500.

Professor Holway made two strong field observations. Of the connection of numbers 397 and 399 taken in Bolivia he records in his field note book "proof perfect," and in a letter to the author, dated February 8, 1921, he says: "With 399 I began to find scattered aecia, and as I approached the big clumps of *Stipa* the aecia became more abundant, until the plants [of *Malvastrum*] next the *Stipa* were 'eaten up.' I never saw better evidence" of genetic connection. Of the Chilean collection on *Nasella* he wrote first on February 9,

1921, that "No. 18 was abundant, and the evidence just as strong," and again on January 4, 1921, "there is the most perfect proof that these [two collections] are connected with the Malvaceous aecia on nos. 17 and 397." These observations accord with similar field observations made in North America, and which have been substantiated by cultures.

The similarity, and sometimes even identity, of many characters found in the heteroecious species, *P. interveniens* and the autoecious species, *P. graminella*, is most interesting and undoubtedly significant. The teliospores in both species have the diverse forms ranging from ellipsoid and dark colored to fusiform and pale in color (Fig. 7), the latter germinating readily. The aeciospores in both species have the same thick, colorless walls and the unusual surface markings, while the aecia show the bag-shape and fibrillar dehiscence in *P. graminella*, although less strongly marked than in *P. interveniens*. The difference might be ascribed to the difference in succulence of the hosts. Undoubtedly the two species are very closely related.

The type collections of all the synonyms have been examined by the writer. That of *Aecidium Modiolae* Thüm., shows slightly smaller spores than in most collections of the species.

57. Puccinia Gymnopogonis Sydow, Monog. Ured. 1: 755. 1903.

*Gymnopogon Burchellii* (Munro) Ekman, Campos do Jordão, São Paulo, Brazil, April 27, 1922, III, *1779*; Mandaque, São Paulo, Brazil, May 25, 1922, III, *1888*.

From the general appearance of the telia and teliospores, and especially from the fact that no trace of urediniospores can be found, it is assumed that this species is a form without uredinia, and that it is heteroecious. It is exceedingly rare that no urediniospores can be found among the teliospores of a full-spored species, however mature the material may be at time of collection. The inferences here drawn are intended to suggest a direction for observation and study to those who have the opportunity to see the rust in the field, or who are working on it with the microscope.

The type collection was taken on *G. foliosus* Nees, Santarem, Para, Brazil, by R. Spruce. It has also been recorded by Spegazzini

on *Gymnopogon* sp. from Oran, Salta (An. Mus. Nac. Buenos Aires **19**: 297. 1909).

58. **Uromyces paspalicola** Arthur & Holway sp. nov.

*Paspalum racemosum* Lam., Huigra, Chimborazo, Ecuador, August 3, 1920, II, III, *823*.

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, usually in small groups on pale spots, oblong, 0.5–0.8 mm. long, early naked, prominent, pale yellow or whitish, somewhat pulverulent, ruptured epidermis inconspicuous; urediniospores globoid or broadly ellipsoid, small, 17–19 by 19–23 $\mu$; wall colorless, thin, 1 $\mu$, finely echinulate, the pores scattered, indistinct.

III. Telia hypophyllous, oblong or linear, in groups often surrounding the uredinia, 0.5–1.5 $\mu$ long, long covered by the epidermis, blackish, teliospores angularly globoid or obovoid, 20–24 by 23–29 $\mu$; wall chestnut-brown, almost uniformly thick, 2–3 $\mu$, smooth; pedicel thin, fragile, colorless.

59. Uromyces leptodermus Sydow; Sydow & Butler, Ann. Myc. **4**: 430. 1906.

*Uredo Panici* Arth., Bull. Torrey Club **29**: 231. 1902.

*Uredo Setariae-italicae* Dietel, Bot. Jahrb. **32**: 632. 1903.

*Uromyces Setariae-italicae* Yoshino, Bot. Mag. Tokio **20**: 247. 1906.

*Nigredo leptoderma* Arth. N. Am. Flora **7**: 224. 1912.

*Uromyces niteroyensis* Rangel, Arch. Mus. Nac. Rio de Janeiro **18**: 161. 1916.

*Uredo Panici-maximi* Rangel, Arch. Mus. Nac. Rio de Janeiro **18**: 161. 1916.

*Chaetochloa caespitosa* (Hack. & Arech.) Speg. (*Setaria caespitosa* Hack. & Arech.), Montevideo, Uruguay, July 29, 1922, II, *2016*.

*Chaetochloa Poiretiana* (Schult.) Hitchc. (*Setaria Poiretiana* Desv.), Prata, São Paulo, Brazil, April 9, 1922, II, *1720*.

*Chaetochloa rariflora* (Mikan.) Hitchc. & Chase (*Setaria rariflora* Mikan.), Jacarepagua, Rio de Janeiro, Brazil, alt. 100 feet, September 4, 1921, II, *1090*.

*Chaetochloa tenax* (L. Rich.) Hitchc. (*Setaria tenax* Desv.), Rio de Janeiro, Brazil, alt. 900 feet, August 10, 1921, II, *1013*; Gavea, Rio de Janeiro, Brazil, January 13, 1922, II, *1474*.

*Lasiacis ligulata* Hitchc. & Chase, Sylvestre, Rio de Janeiro, Brazil, September 16, 1921, II, III, *1117*; San Francisco, Nictheroy, Brazil, September 23, 1921, II, iii, *1148*.

*Lasiacis ruscifolia* (H. B. K.) Hitchc. & Chase, Guayaquil, Ecuador, July 31, 1920, II, *801*.

*Panicum barbinode* Trin., Santa Clara, Peru, July 23, 1920, II, *790*.

*Setaria leiantha* Hack., La Falda, Argentina, August 20, 1922, II, *2035*.

The species occurs throughout the warmer regions of the world on many Paniceous hosts, but rarely produces teliospores. There is considerable variation in the size and wall thickness of the spores and in the presence or absence of hyphoid paraphyses, as would naturally be expected in a species so widely distributed and on so many species of hosts. Teliospores with walls 2–3 $\mu$ thick were described by Yoshino from Japanese material as a distinct species, and the same variation is given under the name *Uromyces niteroyensis* by Rangel.

Other collections from South America represented in the Arthur Herbarium are as follows:

*Chaetochloa* sp. (*Setaria* sp.), Cubango near Nictheroy, Brazil, April 1914, II, iii, Rangel *1172* (*Urom. niteroyensis*).

*Lasiacis ligulata* Hitchc. & Chase, Nictheroy, Brazil, July 20, 1915, II, Rose & Russell *20314*.

*Lasiacis* sp., Gasparee Island near Trinidad, British West Indies, April 2–7, 1921, II, Seaver *3477*.

*Panicum barbinode* Trin., Santa Clara, Peru, July 18, 1914, II, Rose *18723*.

*Panicum maximum* Jacq., Icarahy near Nictheroy, Brazil, June 29, 1913, II, Rangel *749* (*Uredo Panici-Maximi*).

*Uromyces Puttemansii* Rangel (*l. c.*, p. 159) was founded on a collection made at Paquetá Island near Rio de Janeiro, Brazil, June 7, 1914, II, Rangel *1211*, with the host named *Panicum Melinis*, but the single leaf sent to the writer appears much more like that of *Syntherisma sanguinalis*, and this is the opinion of the critical agrostologist, Professor A. S. Hitchcock. *Uromyces Panici-sanguinalis* Rangel, (*l. c.*, p. 159) founded on *Panicum sanguinale*

(= *Syntherisma sanguinalis*) appears to be identical in both fungus and host with the preceding, judging by the material transmitted to the writer. Specimens in the Holway Herbarium also agree perfectly with those in the writer's possession. A very careful search of the four specimens mentioned failed to reveal a single teliospore. Uredinia are abundant in each case, and the urediniospores appear much more like those of *Puccinia substriata* Ellis & Barth. than of *Uromyces leptodermis*, where the illustrations published with the author's descriptions would naturally place them. The status of these two names must be left to future inquiry.

60. Uromyces Microchloae Sydow, Ann. Myc. 1: 15. 1903.

*Microchloa indica* (L.) Beauv., Cochabamba, Bolivia, March 3, 1920, ii, III, *361*; same, La Paz, Bolivia, March 31, 1920, II, III, *490*.

An African rust now first reported for America.

61. Uromyces argentinus Speg. An. Soc. Ci. Arg. 9: 170. 1880.

This species is only known from the type collection, which has been kindly loaned by Señor Spegazzini for the writer to study. It was found at Recoleta, on the Rio de la Plata, Argentina, February 25, 1880. The host was doubtfully considered to be a species of *Stipa*. The writer thinks it is either a species of *Stipa* or *Nasella*. In a paper on the flora of the mountains of Ventana, Spegazzini gives the host as *Stipa Neesiana* without comment. The paper is published by the Minister of Public Works, 1896.

Both urediniospores and teliospores are present, and both are large, with very uniformly thin walls, the former having three equatorial pores. It appears to be a well differentiated species.

62. Uromyces ignobilis (Sydow) Arth. Mycologia 7: 181. 1915.

*Uredo ignobilis* Sydow, Ann. Myc. 4: 444. 1906.
*Uromyces major* Arth. Bull. Torrey Club 38: 377. 1911.
*Nigredo major* Arth. N. Am. Flora 7: 225. 1912.

The only South American locality yet known for the species is the Island of Trinidad, where it was collected by Seaver in 1921, on *Sporobolis indicus* L., II, *3093*.

63. Uromyces Sporoboli Ellis & Ev. Proc. Acad. Phila. **1893**: 155. 1893.

*Nigredo Sporoboli* Arth. Résult. Sci. Congr. Bot. Vienne 344. 1896.

*Sporobolus Berteronianus* (Trin.) Hitchc. & Chase, Panamavida, Chile, October 14, 1919, II, *228*; Cochabamba, Bolivia, March 1, 1920, II, *351*; La Paz, Bolivia, March 29, 1920, II, *481*; Riobamba, Ecuador, August 10, 1920, II, III, *862*; Quito, Ecuador, August 15, 1920, II, III, *898*.

The species has not before been reported from South America. In North America cultures have been made connecting the grass form with aecia on *Allium*.

64. Uromyces Andropogonis Tracy, Jour. Myc. **7**: 281. 1893.

*Aecidium* (*Caeoma*) *pedatatum* Schw. Trans. Am. Phil. Soc. II. **4**: 309. 1832.

*Uromyces pedatatus* Sheldon, Torreya **10**: 90. 1910.

*Nigredo pedatata* Arth. N. Am. Flora **7**: 223. 1912.

*Andropogon emersus* Fourn., Cochabamba, Bolivia, February 26, 1920, II, *325*; Choisica, Peru, July 23, 1920, II, iii, *783*.

*Andropogon saccharoides Berteronianus* Steud. & Hochst., Cochabamba, Bolivia, March 11, 1920, II, *392*; Quito, Ecuador, August 15, 1920, II, *903*.

*Andropogon saccharoides laguroides* (DC.) Hack., Panamavida, Chile, December 17, 1919, II, *239*, *244*.

The species has not before been reported from South America. Its aecia occur on various species of *Viola*.

65. Uromyces Epicampis Diet. & Holw.; Holway, Bot. Gaz. **24**: 23. 1897.

*Nigredo Epicampis* Arth. Résult. Sci. Congr. Bot. Vienne 343. 1906.

*Epicampes macroura* (H. B. K.) Benth., Quito, Ecuador, August 29, 1920, II, *952*.

Heretofore this species has only been known from the warmer parts of North America.

66. Uromyces Eragrostidis Tracy, Jour. Myc. 7: 281. 1893.

*Nigredo Eragrostidis* Arth. Résult. Sci. Congr. Bot. Vienne 343. 1906.

*Eragrostis ciliaris* (L.) Link, Raiz da Serra, Rio de Janeiro, Brazil, alt. 200 meters, November 6, 1921, II, *1281*.

*Eragrostis pilosa* (L.) Link, Rio de Janeiro, Brazil, September 12, 1921, II, *1104*; Bom Successo, Rio de Janeiro, Brazil, alt. 150 feet, September 13, 1921, II, *1105*.

*Eragrostis virescens* Presl, Cochabamba, Bolivia, March 1, 1920, II, III, *356*; same, March 6, 1920, II, III, *372*; Sorata, Bolivia, April 17, 1920, II, *539*; Huigra, Ecuador, August 3, 1920, III, *825*.

*Eragrostis* sp., near *E. contristata* Nees, Cochabamba, Bolivia, March 8, 1920, II, *377*; near *E. lugens* Nees, La Paz, Bolivia, March 26, 1920, II, III, *463*.

Reported here for the first time for South America. Numbers *356*, *372* and *825* show a specially heavy development of telia, indicating that aecia might possibly be found in those localities. No suggestions for the alternate host have yet been made.

67. **Uromyces bromicola** Arthur & Holway sp. nov.

*Bromus coloratus* Steud. Concepcion, Chile, October 29, 1919, II, iii, *150*.

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, scattered, oval or oblong, 0.3–0.5 mm. long, early naked, pale yellow, pulverulent, ruptured epidermis conspicuous; urediniospores broadly ellipsoid or globoid, 20–26 by 23–29 $\mu$; wall pale yellow, 1–1.5 $\mu$ thick, often appearing thicker, finely echinulate, the pores scattered, 6–8, moderately distinct.

III. Telia amphigenous, scattered, punctiform or oblong, small, 0.1–0.3 mm. long, long covered by the epidermis, grayish; teliospores angularly globoid or oblong, 21–23 by 23–30 $\mu$; wall chestnut-brown, almost uniformly thick, 2–3 $\mu$, smooth; pedicel very short, thick, fragile.

The relationship of this species is uncertain. Its general morphology would place it near *Urom. argentinus*, but that species has equatorial pores in the urediniospores. There is a bare possibility that the aecial form recorded on *Bromus unioloides* from Uruguay

Winter, Hedwigia **26**: 13. 1887) may belong here. It was collected at Montevideo, October, 1886, by J. Arechavelata, and has not been reported since. It was listed under the name *Aecidium graminellum*, and stated to agree exactly with that species.

68. **Uromyces pencanus** (Dietel & Neger) Arthur & Holway comb. nov.

*Uredo pencana* Dietel & Neger, Bot. Jahrb. **27**: 15. 1899.

*Nasella chilensis* (Trin.) Desv., San Felipe, Chile, September 25, 1919, II, III, *69*.

*Nasella pubiflora* (T. & R.) Desv., La Paz, Bolivia, March 18, 1920, II, *419*, *420*; same, March 26, 1920, II, *464*; same March 27, 1920, II, *476*.

*Stipa manicata* Desv., Zapallar, Chile, February 1, 1920, II, III, *307*, *310*.

*Stipa mucronata* H. B. K., Temuco, Chile, November 3, 1919, II, III, *160*.

*Stipa setigera* Presl, Papudo, Chile, September 16, 1919, I, II, iii, *25*; Constitucion, Chile, October 20, 1919, II, *134*; same, October 27, 1919, II, *140*; Panamavida, Chile, December 9, 1919, II, *211*; same, III, *211½*; Recinto, Chile, January 10, 1920, I, II, *287–8*.

*Stipa* sp., Viña del Mar, Chile, September 6, 1919, II, *8*; Cochabamba, Bolivia, February 28, 1920, II, *347*.

0. Pycnia unknown.

I. Aecia as in Puccinia graminella, but the aeciospores slightly larger, 21–30 $\mu$ in diameter.

II. Uredinia hypophyllous, intercostal, oblong, 0.5–1 mm. long, early naked, pulverulent, cinnamon-brown, ruptured epidermis evident; paraphyses none; urediniospores globoid or broadly ellipsoid, 23–29 by 26–32 $\mu$; wall cinnamon-brown, 2–3 $\mu$ thick, closely verrucose-echinulate, the pores 6–10, usually evident, scattered.

III. Telia amphigenous, mostly hypophyllous, oblong or elongated oblong, 0.5–1 mm. long, early naked, somewhat pulverulent, chestnut-brown, ruptured epidermis usually evident; teliospores globoid or broadly ellipsoid, 18–26 by 26–38 $\mu$, umbonate above, rounded below; wall uniformly chestnut-brown, medium thick, 2–3 $\mu$, much thickened above, 5–11 $\mu$, smooth; pedicel slender, persistent, once to twice length of spore, colored.

This species adds another to the remarkable variety of *Stipa* rusts. The original collection for *Uredo pencana* has not been seen by the writer, but the description is so explicit, even to the characters of the teliospores found with the urediniospores which were so few that the authors did not venture to regard them as certainly belonging with the uredinia, that there is no chance for doubt regarding the application of the name. The original material was collected by Neger at Concepcion, Chile, on *Stipa manicata*. The teliospores are well shown in the Holway *307* (Fig. 8).

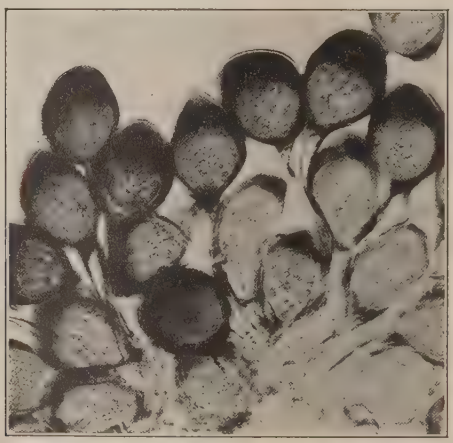

FIG. 8. Teliospores of *Uromyces pencanus* on *Stipa* (collection *307*). × 500.

As in the other *Stipa* rusts having uredinia, there is a wide variation in the size and wall-thickness of the urediniospores. In general the larger the spores the thicker the walls are likely to be, and the more indistinct the pores.

The presence of aecia in two collections, both on *Stipa setigera* and from Chile, appears to leave no doubt that the aecia belong with this species, and not with some species of *Puccinia*, especially as in No. 287–8 both aecia and uredinia are found on the same leaf. As remarked elsewhere, the *Stipa* rusts are greatly in need of study by means of cultures.

69. UROMYCES CUSPIDATUS Wint., Hedwigia **26**: 15. 1887.

*Uromyces fuegianus* Speg. Bol. Acad. Nac. Ci. Córdoba **11**: 181. 1888.

Undetermined composite, Termas de Chillan, Chile, alt. 2300 meters, December 29, 1919, O, I, *256*; same, December 31, 1919, O, *256a*.

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*Festuca dissitiflora* Steud., La Paz, Bolivia, May 13, 1920, II, III, *602*.

*Festuca bromoides* L., Maipo Valley near Santiago, Chile, October 2, 1919, II, *78*.

*Festuca Hieronymi* Hack., La Paz, Bolivia, March 24, 1920, II, III, *460*; same, March 28, 1920, II, *473*, *477*.

*Festuca lasiorrhachis* Pilger, La Paz, Bolivia, ii, III, *604*.

*Festuca megalura* Nutt., Papudo, Chile, September 17, 1919, II, *27*; San Felipe, Chile, September 25, 1919, II, *68*; Maipo Valley near Santiago, Chile, October 2, 1919, II, *79*.

*Festuca Myuros* L., Puerto Varas, Chile, November 21, 1919, II, *180*.

*Festuca procera* H. B. K., Termas de Chillan, Chile, December 31, 1919, III, *260*.

*Festuca rigescens* (Presl) Kunth, La Paz, Bolivia, March 29, 1920, II, *483*; same, April 1, 1920, II, *491*.

*Festuca* sp., Temuco, Chile, November 3, 1919, II, *162*; La Paz, Bolivia, March 20, 1920, II, *434*; same, March 28, 1920, II, *480*; same, May 16, 1920, II, III, *607*.

*Melica laxiflora* Cav., Viña del Mar, Chile, September 5, 1919, II, III, *3*; same, September 6, 1919, II, *10*; Papudo, Chile, September 20, 1919, II, *58*; Temuco, Chile, November 3, 1919, II, *159*; Panamavida, Chile, December 12, 1919, II, *223*.

*Muhlenbergia dubia* Fourn., Sorata, Bolivia, April 16, 1920, II, iii, *530*.

*Muhlenbergia rigida* (H. B. K.) Kunth, Sorata, Bolivia, April 13, 1920, II, iii, *514*.

The original collection of this species was obtained at Cape Horn, the southernmost part of South America (Hariot 7), on *Festuca*

*Commersonii* Spreng. A specimen has not been seen by the writer, but the description given by Winter is that of the condition in Holway *260* (Fig. 9), many of the teliospores being narrow and

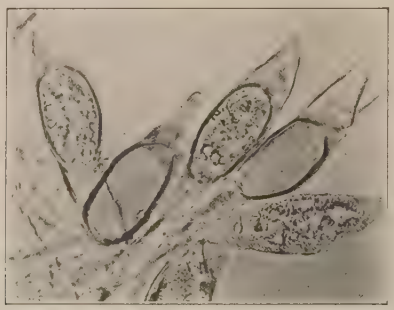

FIG. 9. *Uromyces cuspidatus* on *Festuca* (collection *260*), showing pale, narrow teliospores.

acuminate. The collection made by Spegazzini on Staten Island, Tierra del Fuego, Argentina, on *Festuca purpurascens* Banks & Sol., which has not been seen by the writer, agrees in its description with a collection on the same host, made by Thaxter, in the same general region, at Punta Arenas, Magellanes, Chile, March, 1906, which has an abundance of teliospores, both collections agreeing perfectly with the Holway *3* (Fig. 10).

As stated by Spegazzini (*l. c.*) the two forms are very similar, and from what we now know of other species the differences are to be explained by adaptation to conditions for germination.

The species is clearly related to *Urom. graminis* (Niessl) Dietel, which occurs on *Melica* in various parts of southern Europe. The agreement extends to all the sori and spores, and is especially notable in regard to the aecia, which have been proven by cultures for the European form to occur on umbelliferous hosts. These aecia, like those of *Urom. cuspidatus*, which are on composite hosts, open by pores in pustular swellings of the host, and the fragile, evanescent peridium is extruded, soon to disappear.

Again a most remarkable resemblance is to be seen between *Urom. fuegianus* and *Puccinia Stipae*, the latter not yet detected in

South America. The gross appearance, as well as the minute structure of their aecia are the same in both species, both occurring on various composites. The urediniospores and teliospores are also similar, of course making allowance for two cells in teliospores of the *Puccinia* and one cell in those of *Uromyces*. As in the case of the *Uromyces*, so with the *Puccinia*, a species like *P. Stipae*, *i.e.*, *P. stipina* Tranz., occurs in Europe, but its aecia are on labiates.

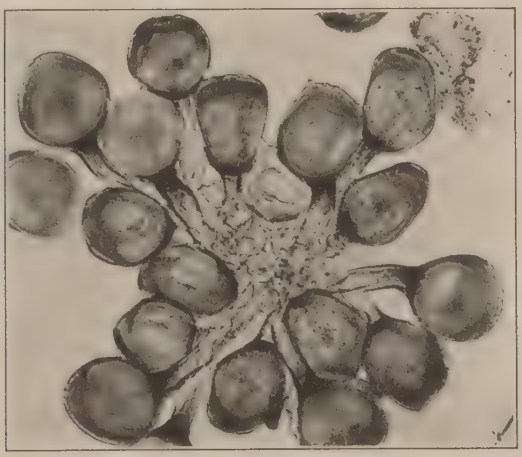

FIG. 10. *Uromyces cuspidatus* on *Melica* (collection 3), showing dark, irregularly globoid teliospores.

This, then, is the curious four-cornered situation. Four species of rusts, having very similar if not identical morphological characters occur in different areas, the sporophytic stages being on essentially the same group of hosts for the two southern species and a different group for the two northern species, but the gametophytic stages on three wholly unrelated host-families. *Urom. cuspidatus* in South America has aecia on composites, in Europe the similar *Urom. graminus* has aecia on umbellifers. *Puccinia Stipae* in North America has aecia on composites, while in Europe, especially northeastward, the similar *P. stipina* has aecia on labiates.

70. Uredo poiophila Speg. Contr. Flora Sierra Ventana 84. 1896.

The original collection, not seen by the writer, was obtained at the mouth of the Cueva del Toro, Argentina, on *Poa lanigera* Nees. It appears to be well characterized by the very thin colorless walls of the spores. No other collections are known to the writer at all similar.

71. Uredo ignava Arth. Bull. Torrey Club **46**: 121. 1919.

*Dicaeoma ignavum* Arth. & Fromme, N. Am. Flora **7**: 341. 1920.

Three collections of this species have been made in Trinidad, British West Indies. One collection on *Dendrocalamus giganteus* Munro, in 1913, by Thaxter *49*, and two on *Bambos* sp., in 1921, by Seaver *2958*, *3111*. It is an inconspicuous rust.

72. **Uredo rubida** Arthur & Holway sp. nov.

*Andropogon condensatus* H. B. K., Petropolis, Brazil, alt. 700 meters, October 30, 1921, II, *1256*.

Uredinia hypophyllous, or chiefly so, on reddened spots, scattered or forming lines, elongate-oblong or linear, 0.5–5 mm. long, early naked, reddish- or chestnut-brown, pulverulent, ruptured epidermis noticeable; urediniospores ellipsoid or globoid, 20–23 by 22–27 $\mu$; wall chestnut-brown, moderately thick, 3 $\mu$, evenly and noticeably echinulate, the pores 2, equatorial, generally distinct.

73. Uredo Setariae Speg. An. Mus. Nac. Buenos Aires **23**: 33. 1912.

Only the original collection is known, of which Dr. Spegazzini kindly sent the writer a portion. It was secured near Catamarca, Argentina, December, 1909, on *Setaria macrostachya* H. B. K. (a synonym of *Chaetochloa macrostachya* (H. B. K.) Scribn. & Merr.). The echinulate surface of the spores clearly distinguishes this from *Puccinia Setariae*, which has urediniospores that are unquestionably verrucose. Both forms have scattered pores in the urediniospores.

74. Uredo Panici-Urvilleani Dietel & Neger, Bot. Jahrb. 27: 15. 1899.

I have had the privilege of examining a portion of the original collection, which was made by Neger, near Yumbel, Chile, on *Panicum Urvilleanum* Kunth. The spores have colored walls, 2–3 μ thick, verrucose, with 2 or 3 equatorial pores.

## Rust Index.

Synonyms are in *Italics*, and new names and combinations in **black type.**

## Host Index.

Synonyms are in *Italics*.